EXPLANATORY LECTURES for NURSES AND THEIR TEACHERS

H. HAWKINS-DEMPSTER

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EXPLANATORY
LECTURES FOR NURSES
AND THEIR TEACHERS

BY

H. HAWKINS-DEMPSTER

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TO THE MEMORY OF

EMILY MANGLES

WITHOUT WHOSE STIMULATING INFLUENCE

THIS VOLUME WOULD NEVER HAVE BEEN WRITTEN

IT IS DEDICATED

PREFACE

THESE Explanatory Lectures are in no wise intended to take the place of the courses of lectures on Elementary Physiology and Anatomy, such as are given to probationers, and which form so invaluable an addition to the short text-books they are expected to study; for, as will be seen, throughout these lectures a certain amount of knowledge thus acquired is taken for granted in those to whom they are addressed. Neither do they constitute a consecutive series. On the contrary, each of the thirteen subjects in this volume, whether treated in one or several lectures, has been made complete in itself, an arrangement which the author hopes may prove helpful as a basis, say to a lecturer called to replace the regular class-teacher for one or more lectures, should there perhaps not be much time for preparing the subject. This arrangement unavoidably involves repetitions here and there, which in a consecutive series would not be necessary.

Written originally for a particular set of nurses, they are now published because the author has been urged to publish them by more than one of the medical men by whom they had been read and thought to prove useful. Their primary object is to create, as far as can be done by lectures, an intelligent comprehension and real interest in those symptoms, changes, and sufferings that nurses see in their patients, and at the same time to help them to understand the meaning and objects of the different treatments which, when ordered by physicians, they may be expected to carry out.

While in these lectures the author seeks to impress nurses with the greatness of their calling, considerable pains are taken fully to explain the importance of what at first sight might appear to probationers to be mere routine work, and to show why that very work, if rightly understood, cannot fail to interest young and old nurses alike. Such, for example, as the variations in temperature, or in the rate and character of the pulse, and the important evidence that is gained by urine testing ; and not least, the endless details to be observed in the constant struggle against the power of those invisible but ever present foes of the "world of the infinitely small," which nurses as well as doctors must maintain if the wounded are not to fall a prey to fresh foes, and the sound not to be numbered among the unsound, or among the dead. In wards and sick rooms there is nothing common or unclean or negligible.

A marked, and intentionally marked, feature in these Explanatory Lectures is the prominent use made of comparisons, analogies and of similies, as a means of promoting a right comprehension of such facts and ideas as otherwise might possibly not be perfectly grasped, but which are accepted quickly enough by those to whom they are presented once they are associated with things of daily life. The author has found this system of conveying information especially helpful in teaching young women in training to become Cottage Nurses who, as belonging to the working classes, had not had many intellectual advantages. Nor perhaps is it less useful for pupils of a somewhat higher social grade, seeing that in every class there are always members who are less advanced, or who learn less readily, than their companions, and that for these therefore every possible aid should be provided to help them to profit by the lectures they attend.

It is in this respect that the author hopes these Explanatory Lectures in part or in whole may prove helpful to teachers of nurses to whom this little volume is respectfully offered.

The author is quite alive to the possibility of misapprehensions arising from a free use of comparisons and would-be enlightening forms of speech, such as was so plainly shown when a distinguished lecturer who, in speaking to a class of his hospital probationer nurses, had said that "the mere moving of people in a room, or a gust of wind, might send all unremoved dust and microbes flying," and concluded by asking a member of his class, "What are microbes ? " received this answer, "They are flies." Most encouraging, no doubt; and all that can be done is, like this lecturer, carefully to cross-examine one's audience.

Though a good many illustrations are given in this book, according to the author's experience it answers better in class teaching not to rely on them, but to be provided with large roller charts, now-a-days to be got at a comparatively small cost (such as are published by H. K. Lewis). With these charts time is saved, for the lecturer has only to point to the organ, or structural details in question, instead of leaving the pupils to struggle, perhaps to struggle in vain, to discover in minute illustrations the 1, 2, 3 or A, B, C that correspond with the 1, 2, 3 and the A, B, C of the letterpress index, a process that takes up the time that were far better given to testing questions and to desired explanations.

The four lectures in "The Two Chapters of Accidents," though they do not directly apply, as do the rest of the lectures, to Nurses in training, have been given a place in this volume on account of their having much in common with the other lectures, inasmuch as they turn on the intelligent handling of wounded persons.

Their original purpose was to help a number of young women, waitresses and housemaids, etc. (drawn from large London restaurants and hotels), and as they answered well with these, the author hopes they may prove equally helpful to others, say for example to the Church Army Mission women attending lectures given by painstaking teachers, themselves holders of "First-aid" medals. They will serve either as additions to the official lectures attended, or as a preparation for them, seeing that for most persons one hearing does not suffice to a complete understanding of subjects that are new.

H. H.-D.

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LECTURES TO NURSES.

SUBJECT I

ON THE KEEPING OF CHARTS

LECTURE I

THE TEMPERATURE OF THE BODY AND ITS VARIATIONS

THOUGH all of you are familiar with the work of temperature taking and marking, I do not think your time will be wasted if what I propose just now to say to you about our to-day's subject serves to excite in you a deeper interest and to give you a wider understanding of this so important a part of a nurse's duty. Further, I hope I may help you to realize how much the course of some patients' variations of temperature, when shown on well-kept charts, with their resulting, and often typical, curves, may reveal to doctors and to experienced nurses. In some cases they may perhaps serve to establish the particular disease from which some fever-stricken or otherwise sick person is suffering, or the degree of its invading force, or they may indicate to those who can read them aright, what is the stage a fever has reached; or finally, foretell death or recovery. Cross influences, by which I mean such disturbing factors as relapses, intervening complications, developed evil consequences, or a previous bad condition of health, in the subject of an acquired infectious disease, may render their interpretation more difficult, or indeed very doubtful, unless supported by other distinguishing physical signs. The more complicated a case, the greater the need for oft-repeated thermometrical observations; the more so that unless constantly taken by night as well as by day, it may well happen that some temperature indication, which is held to be a mark of a certain disease, or which in others is considered to be a sign of great severity of illness, occurs unnoticed. The one I allude to is a second distinct rise of temperature in the night. So also might be lost that enlightening evidence of another temperature peculiarity, namely, the occurring of two or more slight fluctuations at short intervals of time in the hours when the patient's temperature is at the highest, which fluctuations, when duly marked on a chart, go to produce peak-like tracings. For such tracings, wide-spaced charts are required.

No one is likely to interpret aright either a single, or a day's, or a week's thermometrical observations who does not bear in mind what is the normal temperature of the human body, or who does not realize the relationship* which exists between variations of temperature in disease and those daily normal fluctuations which occur regularly at certain times throughout the twenty-four hours within their standard range, which in medical language is called their "excursus," or what I might more familiarly call their "tether." In all but quite exceptional persons this range covers between 1° and 1½°, or it might be 2° F., variably divided into so many points above and below 98·4°, that figure which our arrow-marked clinical thermometers have taught you to think and speak of as the normal temperature of the human body, whereas what it oftenest stands for is the "mean" of the daily range of the body's temperature.

It is through ignorance on this score, or from lack of thought, that confusions arise. Take an example: Suppose a nurse who in the morning has taken and marked down her patient's temperature 97·4° F., were to tell a friend of that patient, concerned about the said patient's slow recovery of strength, that the temperature was a degree below normal, would not the inquirer in all probability be under the impression that the temperature had not yet risen to normal? Only too possibly, however, some persons if told that a patient's temperature was 97·4° might not be much the wiser; therefore I think that in such cases as the above, you would do best simply to say, "So-and-so has this morning a normal temperature," always supposing there is not some peculiarity in the patient in question which proved the contrary in spite of degree numbers.

I think you would give yourselves a good practical lesson, and one that might prove of value in the future, if you would each mark down, say for a week, your early morning and evening temperatures, making a note of anything that occurs in your health which would account for exceptional changes. Then at the end of the week collect the charts, and see what in each is the number of points, or degrees, between the lowest and the highest temperature in the course of the twenty-four hours, and find out how much or how little the temperature ranges differed in degree amongst you, and what were the minimum or morning figures, and what the maximum or evening figures in each.

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* See C. Wünderlich *On Temperature in Disease*, chap. i.

Unless, however, some of you have naturally an exceptionally low or high temperature, I fear, as you are all much of an age, this will not afford you any practice in the making of allowances; for you must bear in mind that often allowances have to be made to account for a temperature which would otherwise seem to be either above or under normal. Where old people and young children are concerned, allowances must always be made. As a rule, these have a temperature about 1° F. higher than that of middle-aged people, but it is not uncommon to find in old people, more especially in the debilitated, that the difference is not that of a degree higher, but of so many points or a degree lower. Allowances also, as I have said, may have to be made for those exceptional persons whose temperature in full health is well below or above that recognized as normal. A single observation of such, or even of their charts, if their peculiarities are not known, may prove misleading, and any chart may lose some of its value as regards the information it should otherwise afford to the doctor in attendance, if the patient's temperature is not always taken at the same hour, or at the times desired by the doctor. Failures in this respect on the part of nurses in hospitals, with their regular times for all duties, are not likely to occur, but I am afraid the same cannot be said of all private nurses, and therefore on such of you as may soon become private nurses, I would impress the importance of exactness on this point. Lack of it no doubt is often due to press of work, or to want of regularity in carrying out the day's work, but I fear it often comes of the nurses concerned being not sufficiently observant of variations in their patient's conditions; such as, when a long-maintained fever temperature begins to rise later in the evening and to fall earlier in the morning, or the reverse. Possibly such nurses are not aware that the former points to the fever's yielding, the latter to its being still on the increase. These and other indications may be lost, or falsified, if temperature observations are not taken regularly at the same hours, or at times directed by a doctor for some special reason, such as in cases of intermittent fevers.

A given and constantly maintained temperature is not peculiar to human beings, but is equally proper to all warm-blooded animals, though with them their temperatures are considerably higher than in man, more especially among birds, whose temperatures average well above 100°. The so-called "cold-blooded" creatures, such as fish and reptiles, have not only a much lower temperature than man, but the degrees of their temperature depend on their surrounding mediums, whereas that of the human body is but little influenced by its surroundings, short of such extremes of cold or heat as are fatal to human life. So little perturbable is the human body in the matter of its specific temperature, as regards external conditions, that though for a moment it may slightly yield to cold, it quickly sets its heat-producing processes to work and, cold defying, re-establishes its normal degree. This is well shown in the fine glow which in healthy persons results on a cold bath, and also in part in high fever in cases of typhoid when applications of ice to the abdomen are made use of, for if these applications are to have more than a passing effect on the patient's temperature, they have to be repeated frequently. But on the other hand, powerful as Nature is, the body must be aided in its cold-resisting efforts by warm protecting clothing, otherwise the cold of the air would act like a continuous cold bath, or like uninterrupted applications of ice, and thus Nature's efforts be defeated.

Before I speak further of those deviations of temperature from the normal which are proper to certain diseases, let us consider, as closely bearing on our subject, what it is which goes to engender, regulate, and maintain a constant specific temperature in the human body. As in all other living creatures, the warmth of the human body is mainly due to constant chemical changes in it, and here you have an example of a universal law, namely, "Whenever a chemical combination takes place, heat is produced." In this instance the oxygen of the air we breathe in, and which is carried by the blood throughout all the bodily tissues, combines with the carbon the tissues contain. The tissues thus become oxidized, or burnt, with the result that heat is produced and that carbonic acid gas, as a waste product, along with water, is given off. Two other sources contribute to a less degree towards heat-producing, for heat is gained wherever there is friction, such as occurs in muscles during any form of exercise, and heat is also gained whenever hot food or drinks are taken. But against these sources of gain there are constant counterbalancing losses, amongst which are the following: Heat lost (1) By radiation and conduction from the body; (2) Through the skin by perspiration; (3) By the lungs, seeing that they perpetually heat the air they take in and as constantly expel it.

Sufficient as these counterbalancing gains and losses may be under ordinary conditions to neutralize any marked or protracted deviations from the normal temperature, this would not be the case whenever the heat of the body under exceptional conditions (such as unwonted exposure to extremes of heat or cold) becomes excessive, or is greatly reduced, were it not that our bodies are possessed of a master regulating power, a power that is capable of enforcing a far greater and more rapid exhibition of the counterbalancing efforts of one or other of those two opposing processes—heat production and heat expelling—than rules in their ordinary more laggard pace of carrying out their equilibrium-restoring work. This regulating power lies in the nervous system, and its orders as regards temperatures are carried out by the vaso-motor system of nerves, that is by the nerves within the blood-vessels, by means of which the blood-vessels are made to dilate or to contract, with a consequent increase or decrease of the blood's flow and all the changes in the body's warmth that this implies. There is also another set of nerves which plays a considerable part. I mean those nerves whose office is that of stimulating or of lessening the action of the sweat glands in their work of producing perspiration.

We do not as yet know how the great motor nerve-centres are stimulated into sending quickening impulses throughout the vaso-motor nerves, any more than we know why fishes and reptiles are able to maintain a constant temperature against the influence of their surroundings. Nor can we account for the fact that some fish and insects are gifted with the power of changing their colour; why some fish when they pass from a river or pool of one colour into another of a different colour should be able to adopt its colour, or how it is that grasshoppers acquire so exactly the colour of the grass or of the dry leaves amongst which they hop, as to be scarcely distinguishable from their surroundings. More wonderful still is the tiny chameleon, which can change its colour several times in a few minutes.

To return to the consideration of temperatures which are abnormal in their daily range, and in their degrees. It is rare in any sickness not to find a difference between the morning and the evening temperatures, with increase of temperature in the latter. The intermittent fevers, which have their maximum temperature in the morning and their minimum in the evening, even with this peculiarity do not form an exception; while curiously enough, sufferers from typhoid fever, if it be regular in its course and not especially acute, during the days when fever is at its highest, sometimes have a temperature range more or less the same as that of an ordinary daily range of temperature, though starting maybe at some point well above the normal. It is as if some air in music were played in a higher key than that of the original score.

Exceptions met with may at times be accounted for by the nature of the treatment or of the drugs given, or it might be that in some particular case the defervescence (the decrease) of the fever started in the evening, and thus the evening temperature came to be the same as the morning one. I am afraid I must add another not impossible explanation, namely, thermometers not sufficiently shaken down, or not long enough retained. A normal length of range by no means holds throughout typhoid fevers; for on the contrary, at times the difference between the morning and the evening temperature may be three times greater than in health, the excursus being say from 98° to 104° F., or possibly one which starts higher and goes higher than those degrees. Such high degrees of heat are constantly to be met with in fever hospitals, but degrees as high or even higher than those that prevail in fever cases occur in other maladies, such as facial erysipelas, purulent (or septic) pneumonia, pyæmia, the small-pox of the non-vaccinated, and highest of all, in tetanus (lock-jaw), while perhaps in these such high temperatures are more ominous than they are in fevers.

A sudden great rise of temperature in a person not suffering from any serious illness, but rather from chronic ailments, or in one only half recovered from some recent illness, is undoubtedly a danger signal, and one too that may speedily bring its fulfilment. Some time ago I had a striking example of this in an emaciated poor girl who had had a slight lingering attack of rheumatic fever,and who had been removed from damp dark quarters to an admirably managed charitable institution. A few weeks after her admission all the main organs of the body began unaccountably to work badly, and ere long her temperature rose within forty-eight hours from slightly above normal to 108° F. Death followed quickly, and during a couple of hours after death the temperature continued to rise, till finally it reached 110° F. Sudden and unlooked-for rises are not uncommon occurrences, though so great a rise as in this instance is rare. An external cancer sometimes proves a case in point; for as a rule, with external cancers the sufferer's temperature varies but little, therefore a great rise tells its own tale.

And little less serious a symptom is a sudden fall of temperature, except in favourable cases of croupous pneumonia, when it marks a promising crisis. In typhoid fevers and gastric ulcers a sudden fall of temperature may indicate an internal hæmorrhage, or in the former that more dangerous and only too common an accident, a perforation of the bowel; while in typhoid and other diseases it may foreshadow death from exhaustion, an exhaustion for which a long-continued high temperature might in part be answerable.

Though, as I have said, a long-continued high temperature may prove a fatal addition to the ravages of an invading disease, still abnormal temperatures in themselves cannot be regarded as constituting maladies, but rather as the recording registers of the evil effects created by maladies and of the body's failing power to maintain its standard temperature. Given any such serious bodily evils as spinal or brain lesions, or blood-poisoning infectious diseases, or blood-poisoning from self-developed toxins, or paralysis of the brain from excesses in alcohol or opium, then that regulating power which—not only under ordinary external conditions, but even, as I have already said, under exceptional ones—is good to maintain a constant temperature, loses much of its influence. Whether it does so irrevocably or not, and to what extent, depends on the force or the nature of the maladies, and on the resisting powers of their victims. Hence come very varied temperatures ; some but slightly above normal, some that constitute true high fever (pyrexia) temperatures, or, on the contrary, temperatures somewhat below normal ; others which either gradually sink, or suddenly drop, into the temperatures of collapse. On those temperature-marking dials, which we call temperature charts, such temperatures as I have named would read pretty much as follows : For slightly above normal, from 99·4° to 100° F. ; for true high fever, in the morning above 103°, and in the evening above 104° ; for a temperature that indicates a fatal termination, from 107° to 108° ; for slightly below normal, 96·4° ; for a moderate collapse temperature, 96° to 95° ; for true collapse, 94° to 92°. Temperatures below 92° or above 109° are held to be little compatible with life, though higher figures than 109° do occur, with recovery. Such high temperatures I think might not unfairly be regarded as the expression of nature's " risk all " efforts to combat an apparently conquering morbid influence—efforts that sometimes do save life, oftenest perhaps when happily aided in the so-called exanthema fevers through their expelling eruptions, or in smallpox by its pustules ; but just as the pustules of smallpox if they form on the eyeballs destroy the sight of the eyes, even so high temperatures, when they overtax flickering hearts, produce heart failure, and thus instead of saving life, extinguish it.

In the figures that I have just given you, which you will do well to remember, you have little more than a few broad landmarks. As regards the figures which mark lesser deviations from the body's normal temperature, these are best learnt through a close and widespread acquaintance with the temperature charts of such persons as are known to you, at least as far as their ailments and fate are concerned. It is only by such direct studies that you will come to know what are the relative position and meaning of such and such degrees or points in the recognized scale of ascending and descending temperatures. But unless you succeed in associating these figures with the conditions they represent or represented, your study of temperature charts will profit you little, and the little you learn will soon be forgotten. If, on the contrary, by calling on your memories you can associate the figures you look at with the symptoms and conditions of individual patients—dead, or passed out recovered—then the figures on temperature charts will become living realities to you, just as do incidents that lead up to the catastrophic or to the happy endings of some really interesting story—those incidents and that story not being likely to be soon forgotten.

A probationer may easily learn very little in this respect, notwithstanding that part of her daily work consists in keeping the charts of several patients, should she, in the press of work, do no more than hurriedly transfer the figures the thermometer indicates, and mark the number of the respirations and the beats of the pulse of her patients, without a thought of how heat degrees, and respirations, and pulse numbers stand in regard to each other, or how they compare, as a whole or in detail, with others among her patients. With such a probationer it would not be wonderful were confusing mistakes to arise, thanks perhaps to a patient who, from inattention or wilfully, did not keep the testing thermometer perfectly covered, or owing to her own incorrect pulse-counting. In either case, the result would be that the proportion between heat degrees and the number of the pulse-beats stood misrepresented on the chart, a misrepresentation she does not become aware of till to her discomfiture it comes to be tested and disproved by the doctor. In the meantime, seeing that in my next lecture I mean to speak about the pulse, I will not to-day say more about how closely temperature degrees and the rate of the pulse are related to each other when both are normal, nor about the deviations from that standard proportion which occur in sickness, some of which are characteristic of certain diseases, and therefore serve in part to mark the said diseases, and some of which when present bring hope, while others go to increase the serious aspect of an already sufficiently grave case. You surely would not willingly create misrepresentation in what often is so serious a matter by careless chartmarking, any more than you would heedlessly give incorrect and therefore misleading evidence if called as a witness in some law court. (See *Figs.* 1, 2, 3, 4, 5.)

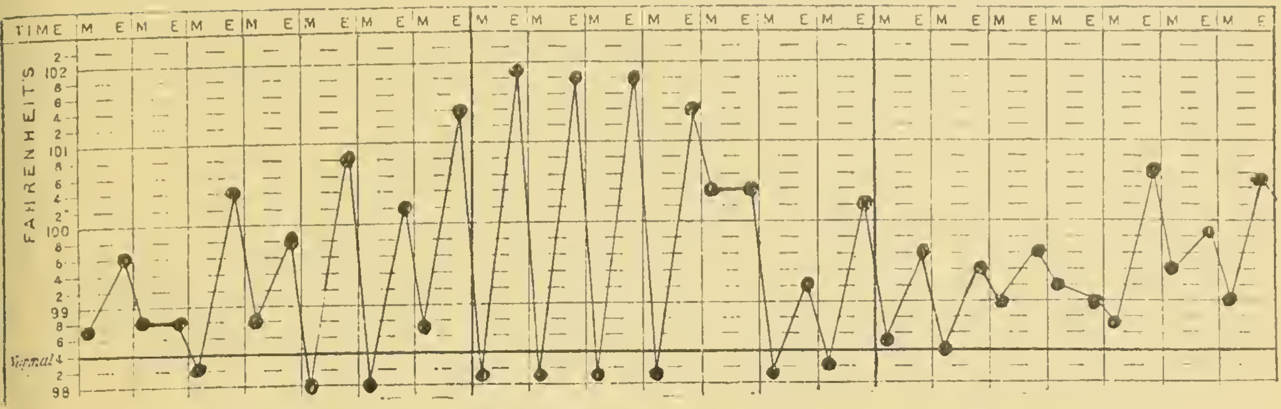

Fig. 1.—Typical pus temperature. *(From Morison's "Introduction to Surgery.")*

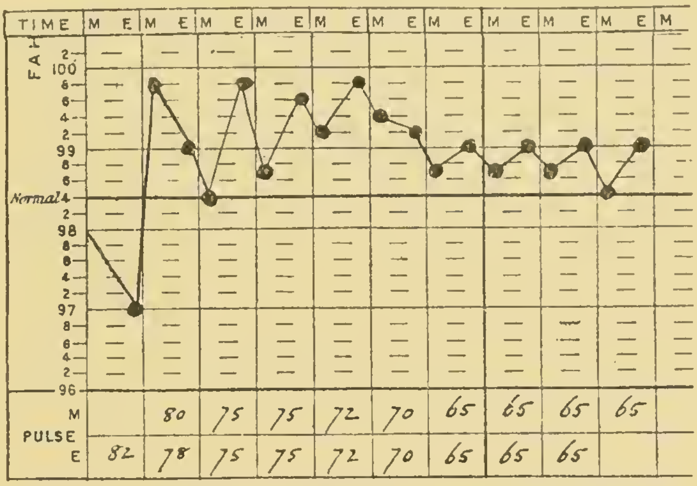

Fig. 2.—Temperature chart of a case of simple fracture. *(From Morison's "Introduction to Surgery.")*

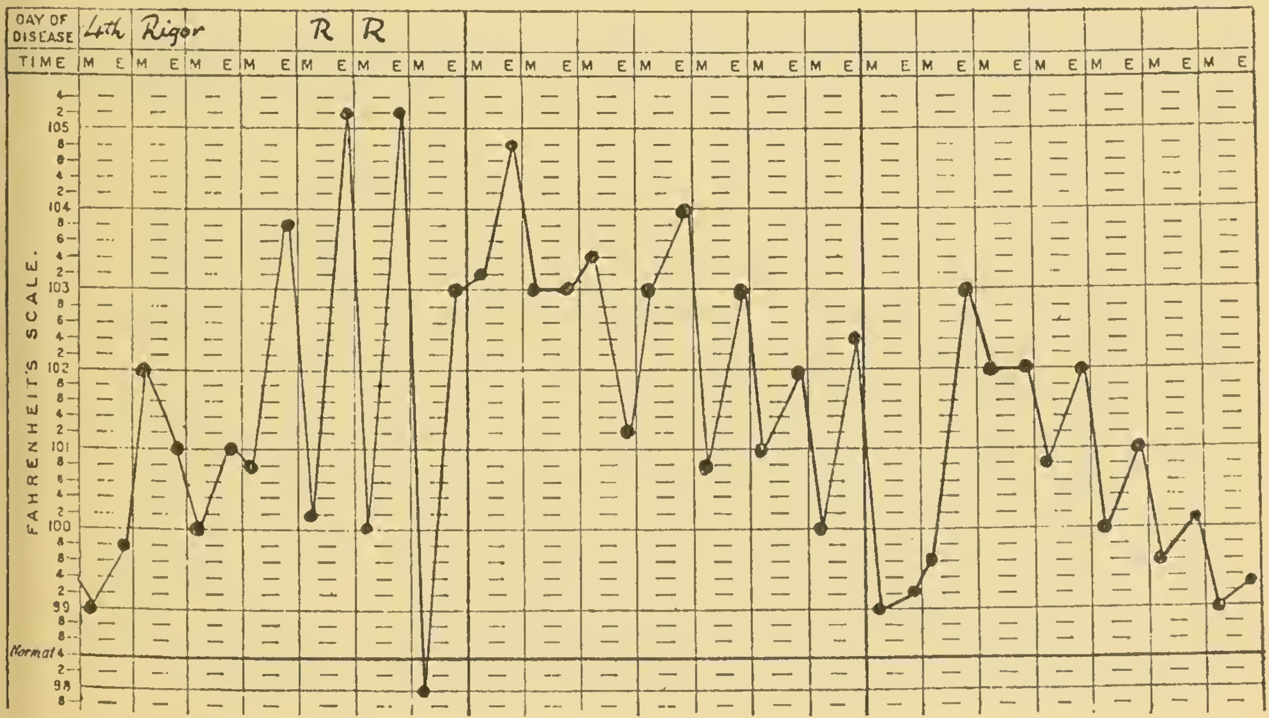

Fig. 3.—Temperature chart of a case of erysipelas. *(From "Index of Diagnosis.")*

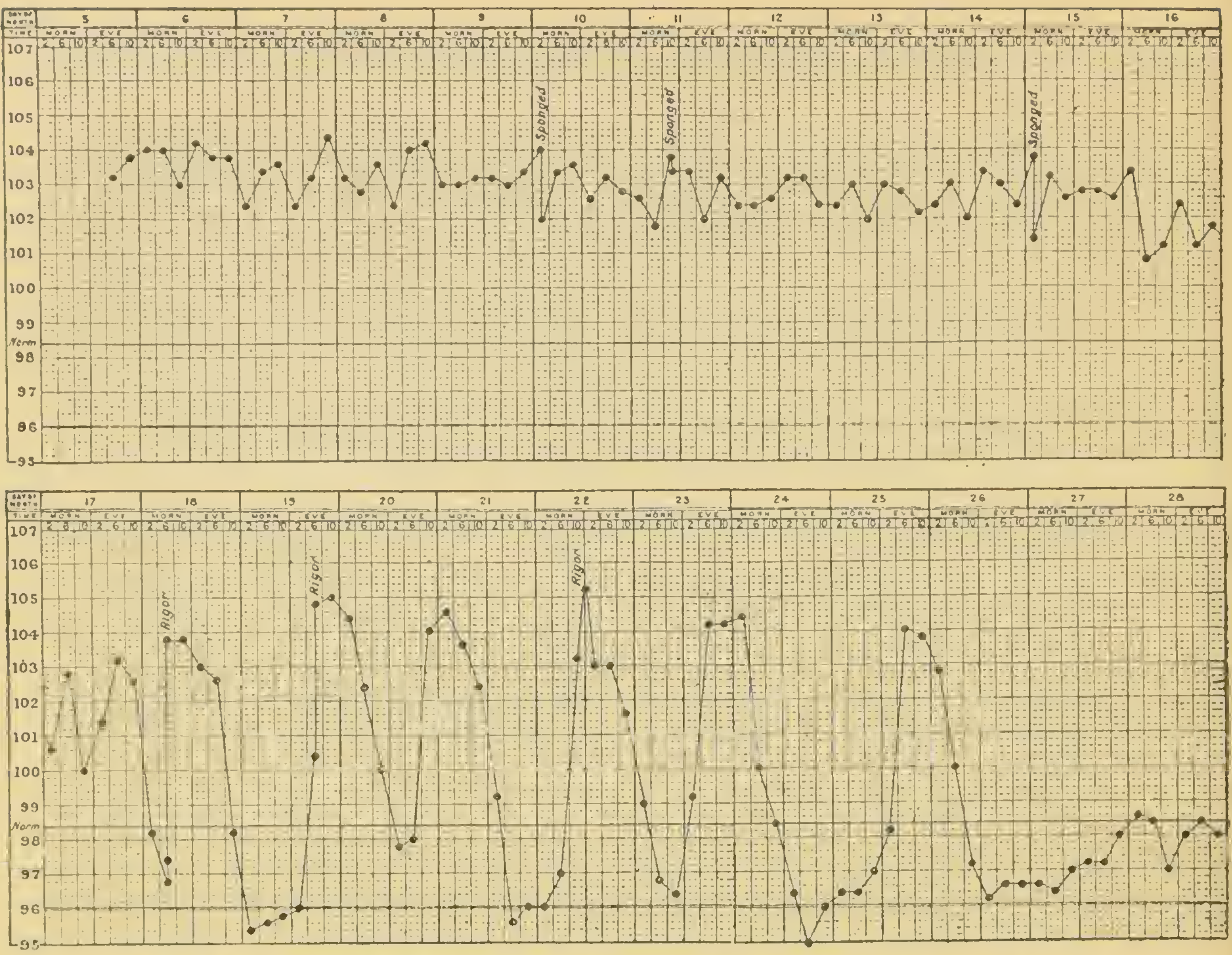

Fig. 4.—Temperature chart of a case of typhoid fever. (*From "Index of Diagnosis."*)

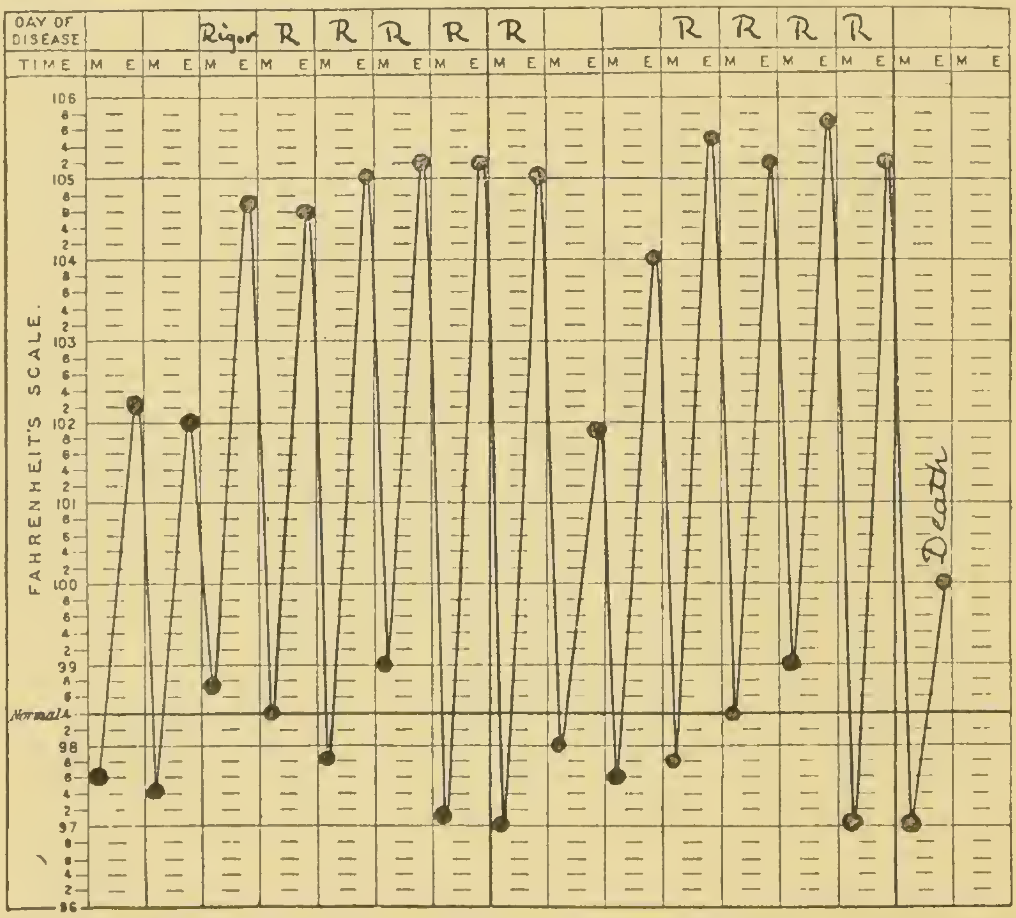

Fig. 5.—Temperature chart of a case of pyæmia, secondary to otitis media and lateral sinus thrombosis. There was a rigor almost daily. (*From "Index of Diagnosis."*)

SUBJECT I continued.—LECTURE 2

THE PULSE: ITS VARIATIONS IN RATE AND IN CHARACTER

TO-DAY, as promised, I will again speak about the keeping of your patients' charts, taking as our subject, "The pulse: its variations in rate and in character." It is more especially to the latter that I wish to direct attention, seeing how much the character of some pulses—though less striking than the rapid fever pulses—may reveal as to the present condition of an individual's health, its past history, and its future, for good or for evil. To become competent to read a pulse aright, and to recognize the differences and peculiarities in the pulses that come under your fingers, you have to learn how most advantageously to place your finger and hand, and how to deal with the different types. Just as anyone desirous of becoming a good piano player has to learn what position of his fingers and wrist will give him the light touch needed for soft movements, and the firmer touch for *forte* passages (a touch far removed from mere thumping), even so in pulse testing, slight must be your touch if you wish to avoid obliterating a weak soft pulse, and firm your touch when a well-regulated pressure is required to determine the strength of a full but not much marked pulse.

"TAKING THE PULSE" AND "FEELING THE PULSE."

In counting the pulse you have no such reliable an instrument to help you as you have in temperature testing in the invaluable clinical thermometer, which unaided acts and registers. On the contrary, the implement for testing a pulse-rate is a finger, which, unless well trained, can hardly be a reliable one. Also, the said finger has to deal with conditions from which the thermometer is exempt; I mean the irregularities so constantly met with in the pulses of the sick, that occur suddenly, owing to various causes, such as mental or nervous excitement, a fit of pain, or faintness, or perhaps to nothing more than an altered position; not to speak of beats missed out at irregular intervals. All this has to be well understood and reckoned with, if the marking of a pulse-rate per minute is not to be a work of imagination, but is to represent a faithful record.

If you desire to become fit for the responsible duties which await you when you take up private nursing, you ought to turn your attention while here, where the wards offer an ample field, to the study of the differences in the character and quality of the pulses of the suffering people with whom you have to deal. What is more, you ought to study and practise on the pulses of healthy persons, so as the better to educate your touch and power of making comparisons. In this way you would learn how to distinguish, say, between a soft and a hard pulse, between a weak and a strong one, between a complete and an incomplete one; to distinguish between an intermittent pulse and what is known as a pulse with "linked beats," and to mark other pulsatory peculiarities, important because of what they indicate for good or for evil.

Before I enter into this, it would be well to make sure that you know what it is that rules the pace and the character of the pulse, both in health and in sickness; for as the knowledge of the grammar of some foreign language helps the student to translate aright a puzzling passage in the said language, so a knowledge of the properties of the arteries and of the forces which rule the circulation will help you to read pulses aright. The upward swelling and downward sinking of the pulse have their origin in the alternate contractions and expansions (systole and diastole) of the heart, which recur as a rule once in a third of a second, that is, on an average, 70 times to the minute in men and 80 in women. The result of each contraction of the left ventricle is that the blood which that cavity contained is projected into the aorta, which, though already well filled with blood, is able, by reason of the elastic nature of its walls, to make room for these additions to its onward-flowing contents, along the surface of which each successive impetus-propelled jet of blood rushes at a speed greater than that of the blood-current.

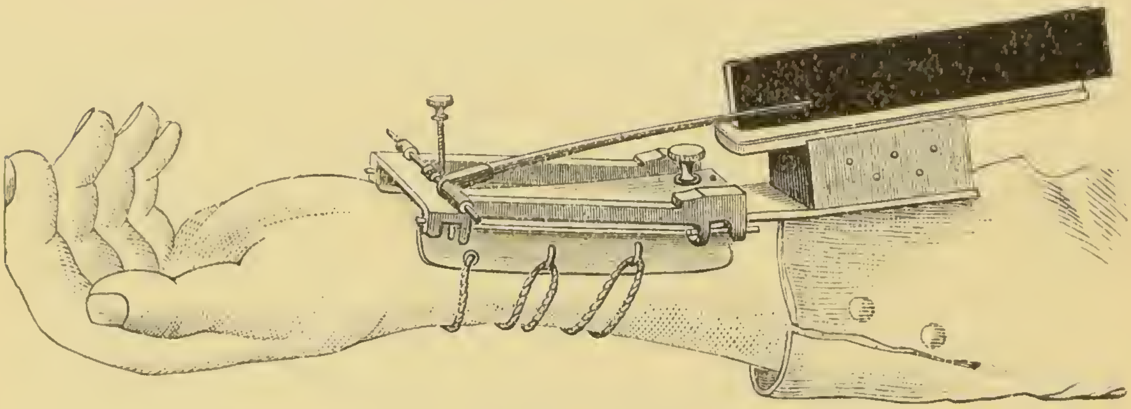

Fig. 6.—The sphygmograph.

This pace, however, grows less and less as these blood-waves advance, owing partly to the endless divisions and sub-divisions of the arteries and arterioles and of their branches, and partly to the force they expend in forging their way through the channels of these vessels, more especially through the narrow arterioles, and to the friction involved, till at last both pace and force subside in the capillaries. It is the increased blood-pressure created by these intermittent additions—so many times to the minute—which constitutes the pulse, causes the beats we count. Less perceptible, however, would be those beats did not the finger by its compressing action on the pulsating artery somewhat diminish the size of that artery's channel, and so further increase the blood-pressure within it, by thus partially arresting the passage of the blood. The falling off of the pulse corresponds to each decrease in the blood-pressure that takes place in the intervals between the contractions, or systole, of the heart, during which intervals no blood is sent out of the heart into the aorta. The frequency of the pulse and its rhythm are ruled by the heart, but as regards high or low tension (blood-pressure), the condition of the walls of the arteries, and above all the contracted or dilated state of the arterioles, form important and varying factors. Though the beats of the pulse correspond, as I have said, to the beats of the heart, the jerky character of the latter and some of that strength which enables each heart-beat to give a perceptible tilt to the apex of the heart, are considerably modified in the pulse-beats, even in the most marked pulse.

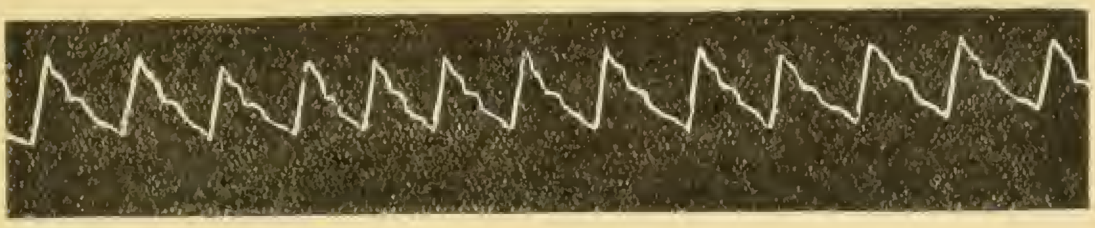

Fig. 7.—Normal pulse.

Considerable additional knowledge of the movements of the pulse was gained by the invention of the sphygmograph, a small apparatus which, when adjusted on the wrist, reproduces the pulse movements by means of a light and easily moved lever attached to a pressure-applying button, which lever as it sways leaves tracings on a specially prepared piece of paper (*Fig.* 6).

Given the typical pulse of a normal adult, a sphygmograph of one pulse-beat would show an almost vertical and unbroken line of ascent, while the line of descent is a sloped and more gradual one, broken at intervals by three lesser rises (*Fig.* 7). The upper point of the angle is called the "primary wave," and the middle one of the three lesser rises is known as the "dicrotic wave." This dicrotic wave in a soft pulse is sometimes so pronounced as to rise to nearly the level of the "primary wave," and as such is very perceptible to the finger, which it is not in a hard pulse, and but slightly in a medium one (*Fig.* 8).

Endless are the divergences from the type of pulse I have described—variations which depend upon the action of the different factors which go to produce the pulse, and upon how much the influence of one or more of the combining factors preponderates over that of the others. It is only from such a book as Mackenzie's important work on the pulse, with its many illustrations of pulse tracings, that an adequate idea can be gained of how numerous are the variations to be met with in the pulse, not only in sickness but at the different stages of life, and in the pulse peculiarities of some healthy individuals. Certain diseases, such as fevers and heart lesions, have their own more or less standard stamp of pulse, and if unaffected by complications, their characteristics are as obvious to the touch as is a sphygmometer tracing. With practice such pulses can be readily detected.

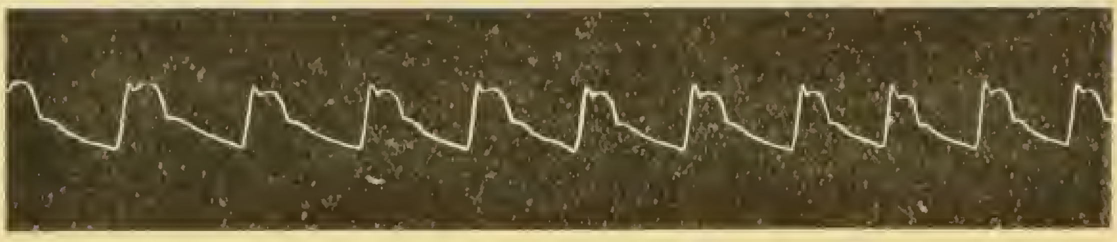

Fig. 8.—The dicrotic wave in a soft pulse

The pulsations of the arteries can be felt only in such as are not deeply buried, and in those which cross or run alongside of a bone or some other resisting plane. This condition enables the finger, when necessary, to give a complete compression to the artery, with the result already mentioned. Much pressure should not be applied unless the object is to test the strength of the blood-pressure, otherwise you risk obliterating the pulse at the moment you wish to count it.

The radial or wrist pulse, besides being the most conveniently placed, fulfils the requirements I have named, and is therefore almost invariably the one counted, except where, owing to an accident, both arms may have been damaged, or where by reason of a patient's weakness it is difficult to make out its beats. In such cases the sub-clavian may be counted, the pulsations of which are at all times somewhat stronger than those of the radial, owing to its closer proximity to the heart, springing as it does directly from the arch of the aorta. It is easily found by passing the finger lightly under the collar-bone in the angular depression between the base of the neck and the shoulder—in what children call the "bird's nest," and which in thin persons is very marked—and then pressing downwards on to the underlying rib. In stout middle-aged people few pulses are visible, and not many easily felt, but in the aged, especially if thin, the number that can be felt is considerable. One pulsating artery there is, namely the anterior (forehead) branch of the temporal, which not infrequently becomes so conspicuous on the bony brows of old men from its worm-like shape and movements, that no finger is needed to detect it.

THE CONDITIONS WHICH MAINLY AFFECT THE RATE AND THE CHARACTER OF THE PULSE.

The character of the pulse mainly depends on the following conditions :—

1. Whether the heart is sound and powerful enough to contract regularly, and in contracting to eject several ounces of blood into the aorta, some 70 times in the minute.
2. Whether the walls of the arteries have become solidified by age or disease, or are still flexible and elastic.
3. Whether the arterioles are blocked or afford an easy passage to the blood, or are over-contracted or over-dilated.
4. Whether or not more than one bad condition affects the pulse.

If you will bear these pulse-influencing conditions in mind, you will find it easier to understand, for example, how a pulse which is a full one may none the less be a weak one, and how a like type of pulse may be produced by dissimilar causes. This and more I will try to explain, starting with those pulses which are to be found both in the sick and in the healthy, or at least in non-invalids, and passing from these to show you how it is that certain diseases affect the rate and the character of the pulse.

A pulse may be either large or small in volume. The former represents strong heart-action and yielding arterial walls. The latter tells of unyielding arteries and weak heart-action. A large pulse may be either strong or weak ; so also may a small pulse. It is strong if the upswelling of the pulse holds for a little, and weak if the upswelling fades quickly away between the beats. But sometimes another interpretation has to be given to the rapid subsidence of a pulse-stroke, as for example in the curious "Corrigan" or "water-hammer" pulse of aortic regurgitation. The very sudden collapse which follows a singularly sharp stroke is one of the distinguishing features of that valvular disease, and is so marked that even a beginner can scarcely fail to notice it. There is, however, a nearly similar stamp of pulse which must not be confounded with the "Corrigan" pulse of aortic regurgitation. It is not infrequently to be met with in old people, in whom an acquired hypertrophy of the heart keeps up the circulation of the blood, in spite of the arteries being affected by atheroma—for atheroma works to destroy the elasticity of the arterial walls, with the result that they cease to be helpful in maintaining a constant and even flow of the blood into the capillaries. With these combined conditions the pulse gives a high up-stroke followed by an abnormally deep fall. This falling off is not so sudden, nor does the radial artery empty so much, especially when the arm and hand are held up, as is the case with the "Corrigan" pulse. Still, here we have an example of a somewhat, if not altogether, similar result brought about by different causes; for the collapse in the pulse of aortic regurgitation is due to an imperfect closure of the aortic valves, which allows some of each jet of blood ejected in systole to fall back into the left ventricle, and also deprives the column of blood in the aorta of its support (or fulcrum), hence the almost complete emptying of the radial artery; whereas the cause of collapse in the senile pulse lies in the degenerate and no longer co-operating arteries, not in any defect in the heart's mechanism. In both, the arteries tend to enlarge and to become tortuous. Indeed, when excess of blood-pressure has been of long standing, these features become very marked in vessels which lie near the surface or against a bone, such as the radial and the forehead branch of the temporal artery; while on the arm very striking is the way the curves of the lengthened radial form and disappear with each systole.

So numerous are the pathological and other disturbing conditions which go to create blood-pressure, either directly or indirectly, temporarily or permanently, that to-day I must pretty much limit myself to the more direct causes.

Among the causes that give rise to high arterial pressure are: (1) Valvular diseases; (2) An impaired or blocked state of the arteries; (3) Hypertrophy (strengthened heart action), along with the last-named condition; (4) An over-contracted state of the arterioles and capillaries. The last is the commonest cause, by reason of its being the outcome of many disorders. I ought perhaps to add to this list of direct causes an obvious one—that of a general over-fullbloodedness, and against this put high blood-pressure for which no explanation can be found beyond a hereditary predisposition, the heart and the blood-vessels being sound and no disease apparently existing.

In valvular diseases, all of which serve to lessen the heart's blood-pumping efficiency, and more or less to disturb the course of the circulation, a hypertrophic strengthening of the heart walls and cavities when it occurs, prevents valvular lesions from proving as destructive to life or health as they would be without this compensating hypertrophy; while when valvular lesions are of the kind which allows blood to return into the chamber from which it had been ejected, then along with hypertrophy an expanding dilatation takes place, which sufficiently enlarges a cavity to enable it to receive, besides the ordinary quota of blood which pours into it, as much of the additional blood as the imperfect closure of valves permits to return into it.

The effect on the pulse is by no means alike in mitral and in aortic regurgitation, for in the former there is neither the sudden upstroke nor the sudden almost complete emptying of the artery that there are in the latter. One reason for this difference is that the imperfect closing of the mitral valves does not deprive the column of blood in the aorta of its fulcrum, as does an open condition of the aortic valves. The pulse in mitral obstruction is commonly small, slow, and fairly regular, except when hypertrophy has either not developed or is failing, for then it will show both great weakness and irregularity. When this is the case, along with a slow, feeble, and irregular driving of the arterial blood and the resultant delay in the venous return, there comes engorgement of the pulmonary vessels, and a passive congestion of the liver (in which organ a tale-telling pulse may be felt), that ends, in bad or long-continued cases of mitral stenosis, in the so-called "nutmeg liver." Later, after a shorter or longer time, the right half of the heart, on which has rested the strain of maintaining the pulmonary circulation, breaks down; it may be from the failure of its mid-valve (the "tricuspid" valve), or through the imperfect closing of the valves of the upper vena cava after it has poured its quota of blood into the right auricle, or owing to both. Hence, when the right auricle contracts, instead of all the blood it contained passing into the right ventricle, some of it re-enters the upper vena cava, and forces its way backwards and upwards into the jugular veins by other communicating veins, where that curious phenomenon of a pulsating vein forms a striking feature in the neck of such sufferers. The jugular veins, however, are not the only blood-vessels in the neck that may be seen to pulsate, for with aortic regurgitation the external carotid artery will pulsate with all the force and suddenness which characterize the pulse of that valvular disease.

Though I spoke to you of the gain that dilatation combined with hypertrophy brings to hearts impaired by valvular lesions, you must not look upon dilatation as an advantage in any other condition of the heart. Quite the contrary, for if it occurs unneeded, or when it outstrips the hypertrophy in amount, it then renders the heart incapable of perfectly carrying out its blood-propelling contractions, and then the heart might truly be said to work no better than a feeble or a childish hand which is unable effectually to squeeze water out of a sponge. What is more, with a heart debilitated by dilatation, any sudden exertion or excitement, or any weakening ailment, may bring about a fatal heart failure.

Nor is hypertrophy always, or altogether, an advantage, for the force which a compensating hypertrophy gives to the heart's propelling actions puts a perilous strain on the blood-vessels. In some persons this strain hastens that loss of elasticity of the arterial walls which age inevitably brings, and so increases the blood-tension, while in persons in whom that change has already taken place, the rupture of an arteriole on the brain may reveal how dangerous had been the strain which the strength gained from hypertrophy had put on the blood-vessels.

Now we pass to what is so frequently the cause of high arterial tension, namely an opposition to the passage of the blood into the veins which is due to an abnormally contracted condition of the arterioles and capillaries, and which is overcome only by an increase in the heart's blood-propelling force. Thus the delay in the passage of the blood is obviated, and the accumulation of blood in the arterial system is kept down. A healthy heart will prove equal to this task, and this work will add to its muscular strength; and also at first the arteries may hypertrophy. In irreparable Bright's disease the arteries are often unusually thick. But if this high arterial tension continues, and if the cause of contraction is constant and is one of long standing, either the heart, or the arteries, or both, will eventually succumb to the strain to which they have been subject. If the arteries, a ruptured blood-vessel in the brain may not improbably foreshadow a fatal result; if the heart, then a paralysed state of the ventricles, or extreme dilatation, may bring about heart failure.

The high arterial tension so marked in renal diseases, and to a less degree in diseases such as gout, diabetes, lead poisoning, and others, is caused by the contraction of the arterioles and capillaries of which I have just spoken. This contraction is due to the presence in the blood of certain bad elements which, by chemically altering the composition of the blood, act on the vasomotor nerves and on their centres in the brain and in the spinal cord.

Where there is insufficient working of the kidneys, the waste products of the body which the kidneys have failed to eliminate go to contaminate the blood, whereas in gout the bad elements with which the blood becomes charged are rather the outcome of some imperfect or badly carried out digestive changes, while in the uræmia of advanced renal disease, where little or no urine is passed, the retained water further serves to increase an already over-high tension.

That bad elements in the blood should produce contraction of the arterioles may at first seem strange to you, but not if you remember how readily the blood-vessels respond to certain drugs much used in medical practice, one set of which has the power of inducing arterial contraction, and another arterial relaxation, which drugs, by reason of their respective properties, are known as "Vasoconstrictors" and "Vasodilators." For example, there is nitrite of amyl, the effects of which are so immediate and striking, in the quick flush it produces in the face, and in the blessed relief it brings from the excruciating pain proper to angina pectoris. In this singular malady, in which undoubtedly a cramp-like contraction of the blood-vessels is the pain-creating factor, nitrite of amyl, which exerts so expanding an influence on the whole vascular system, brings a ready relief. Aconite also has a dilating power. Digitalis and ergot of rye are useful vasoconstrictors, for though so far I have spoken to you mainly about the contraction of blood-vessels, you must not overlook the fact that blood-vessels are also subject to over-dilation. The former condition prevails in some stages of certain fevers; for though as a rule a raised temperature tends to relax the peripheral blood-vessels, and so lessen tension, yet in exceptional cases the poison which is their exciting cause overpowers the relaxing effect of the pyrexia. Otherwise, whenever there is failure in the heart's muscular power, whether due to valvular disease, alcoholism, or to extreme exhaustion consequent on acute disease, the pulse is one of low tension.

The soft pulse of low tension is not always a pathological one, for it is sometimes met with in varying degrees in health, in which case it is merely an idiosyncrasy. A striking symptom in persons with very soft pulses is a great tendency to fall asleep when standing, whereas on assuming a recumbent position they become wakeful, and such persons are often bad sleepers at night. A probable explanation of this peculiarity of the sleeplessness is that more blood remains in the brain of soft-pulsed individuals (with their relaxed blood-vessels) when recumbent than when standing.

But sleeplessness is more often one of the many evil effects of high arterial tension, as most sufferers from Bright's disease only too well know. In high arterial tension due to damaged or ill-working kidneys, as in Bright's disease, vasodilators can do but little towards counteracting the persistent contraction of the arterioles and capillaries produced by bad elements in the blood; yet certain drugs and special dieting may help to reduce the tension and obviate some of its ill effects. Vaso-dilators, indeed, in as far as they act on the heart walls, may thereby lessen the power of the heart to fight obstruction. Hence all that remains for persons in whom the blood-pressure is too strong, either from widespread sclerosis in arteries no longer elastic or from such a contracted condition of the arterioles and capillaries as delays the passage of the blood into the veins, with a consequent overcrowding of the arterial system, is to avoid whatever might cause increase of the arterial pressure. Amongst such causes are over-eating or over-drinking, unwonted or sudden muscular exertion, mental excitement, or bursts of passion, all of which serve to increase blood-pressure, with the consequent risk of a blood-vessel rupturing, which, if on the brain, would mean apoplexy. Not without similar risk is over-straining at stool; therefore should you at any time have a patient injured by an accident, whose pulse indicates a dangerously strong arterial tension, avoid such risk by the use of laxatives or enemas.

You will know that a patient's arterial tension is high, if on inspection you can roll the radial artery under your finger like a cord. The fact that it is possible so to roll it proves that tension is high. But as to less degrees of tension, the amount will be in proportion to the pressure required to suppress, that is to close, the artery. You will understand this at once if you think of a piece of rubber tubing, which when empty you can easily flatten at any point you choose by pressing it between your finger and thumb, but which defies your doing so when it is distended with water, and still more so if it is old and therefore hard. This fairly represents such arteries as I have described; for when you test the radial artery by the pressure of your finger, the hard radial bone against which you drive it plays the part of a thumb to your finger, while the amount of pressure you have to apply in order to flatten the said artery, will vary according to the amount of blood in it and the condition of the arterial walls.

To return to the soft pulse of low tension, which is not so easily counted as the pulse of high tension. Low tension may vary in its degrees, and under certain conditions it varies as to its pathological importance, according to whether it is due simply to the facility with which the arterial blood passes into the veins owing to a dilated state of the arterioles and capillaries, or to that facility being further increased by the small amount of blood ejected by the heart in each of its contractions; or whether it is due to the condition of the heart's action. When the quantity of the blood ejected is unduly small, the tissues suffer from insufficient nourishment, unless this is compensated for, as is often the case, by an increased frequency of the heart's blood-ejecting contractions. Otherwise, with time, the heart fibres, as well as those of the other organs of the body, will suffer, and a vicious circle be established.

The stroke of a pulse of low tension, when the amount of blood passed through the arteries is not unduly small and the heart is not feeble (though not strong), is quite distinct, and though it falls off at once, the dicrotic rebound is also distinct, so much so that you might perhaps mistake it for an independent beat. With the passage of less blood, but with the heart acting well, both the upstroke and the dicrotic wave will be somewhat less distinct, but still such as can be counted without difficulty by a person with a delicate touch.

No such certainty, however, attaches to the testing the rate of a soft pulse when not only is the amount of blood passing through the artery small, but the action of the heart is also feeble; and unfavourable indeed is the prognosis when the pulse tells of incomplete heart contraction, with more and more marked irregularities. Again, a low tension pulse is a bad sign in a patient whose pulse has been the pulse of high tension common to his disease.

To read soft pulses aright requires practice, so easy is it to obliterate the soft pulse, and still more so when a failing pulse assumes the character I have just described. Indeed, in such cases it may be necessary to watch the heart beats in order to ascertain the rate of the heart contractions, which so poor a pulse can only imperfectly indicate. To make sure of not obliterating a soft pulse, you would do well not to give more than 15 seconds to counting it, for the number of beats your finger feels in those fifteen seconds, multiplied by 4, will give you the rate per minute. With a very irregular or intermittent pulse it is safer to give 30 seconds, and if you are not satisfied that you have counted aright, repeat the counting.

In feeling a pulse, flex the patient's wrist slightly, and press your own thumb against the back of it, for by so doing you acquire a facilitating position for your testing finger or fingers, as thereby your wrist is arched and the last two phalanges of your fingers rest almost perpendicularly over the radial artery, so that you naturally will make use of the most sensitive part of the finger, namely, the soft pad beside the nail.*

I have dwelt at such length upon the character of the pulse and the different causes which effect variations in it, that I have left myself scarcely any time to speak of its other important features: its rate per minute, and its variations in rate in sickness. It is seldom that the pulse does not quicken somewhat, in any ailment, however slight, while as to pace, it is in the soft fever pulses that the highest pulse-rate rules, though it is true that with heart troubles the pace may be very considerable, even when these are not organic but purely functionary. In fevers, as a rule, the pulse-rate does not increase until the temperature has risen to fever point, after which an increase of ten beats to each degree in the temperature is usual, though when the temperature attains a high figure this proportion may not always hold good. In any illness, however serious, it is always a good sign if increase in the pulse-rate is relatively less than that of the temperature. *Per contra*, a maintained rapid pulse when a fever temperature has dropped is ominous, indicative possibly of some developing complication or of failing strength in an exhausted subject. Scarlet fever is an exception to the rule I have named, for the pulse quickens at once along with the rising temperature, and often continues exceedingly rapid throughout its whole term, especially in children; pulse, temperature, and a profuse eruption marking in such cases the extreme virulence of the malady.

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* "On Feeling the Pulse," W. Ewart, p. 21.

As regards the pulse in small children, you must bear in mind that with them the pulse in health is more rapid than in adults. Perhaps before I close this long chapter on pulses and blood-vessels, you might like an explanation of this fact. In infancy and very early life, the size of the main arteries is large out of all proportion as compared with the size of the body and the heart, hence low blood-pressure and a rapid pulse in infants (about 120), with a consequent abundant amount of blood which constantly and rapidly flushes the tissues throughout the tiny body. This supply of blood is well in excess of what is required for the quickening and maintaining of so small a frame, but on the other hand, is not more than is needed to promote the rapid growth so characteristic of babyhood and childhood. The arteries by no means keep pace in their growth with that of the heart and of the body; thus it comes that with years a change takes place in the proportion they bear to the size of the heart, with a resulting gradual increase in the blood-pressure and a corresponding slowing of the pulse. Besides these two modifications, there follows a gradual lessening of the amount of the nutritive fluid which passes throughout the tissues, till at last in full manhood a fixed well-balanced level of the blood-pressure is established; or, in other words, the heart of a full-grown man brings a greater propelling force to bear on the resistance which the much lengthened but no longer out of all proportion wide arteries offer to the blood which the heart ejects with its fully-developed force.

SUBJECT II

THE VALUE OF URINARY EVIDENCE

Lecture I

THE KIDNEYS: THEIR STRUCTURE AND OFFICE. THE ALBUMINURIA OF BRIGHT'S DISEASE.

You will rarely nurse a patient without the attending doctor requiring specimens of the urine for testing purposes, if you have not also to collect and register the daily amount passed, while later on in your profession you may be called upon to do some of the simpler forms of urine testing. Once you realize what an increasing or decreasing amount of urine may imply, and what testing or the microscope may disclose, you will not regard this duty as an objectionable part of your office as a nurse, but rather as one which opens up to you a line of intelligent interest.

It is mainly on three points that the examination of urine turns, or is put, as it were, in the witness-box, and its evidence taken as proof for or against the presence of functionally disordered or structurally diseased organs.

They are: (1) Quantity; (2) Specific gravity; (3) Quality, or Composition.

The first means—Is the daily amount above or below the normal average (50 oz.)? The second, Does the specific gravity—i.e., the weight as compared with water of a given specimen—exceed or fall short of the normal (1015 to 1020), water being reckoned at 1000. The third covers first the relative proportion of solids to water, already so far decided by ascertaining the specific gravity; second, the presence of abnormal constituents; third, the proportionate increase or decrease of normal constituents; fourth, the absence of any normal constituents; and fifth, the presence or absence of micro-organisms.

Certain substances met with—as albumin, sugar, bile, blood, pus etc.—are abnormal or morbid constituents, indicative of disease or of disorder; but so, too, may be too large a proportion of some normal constituent, or the decrease or absence of some other. For example, urea—that great waste-product of our changing bodies, and the main solid constituent of urine—when unduly increased speaks of fevers, or of diabetes; while its sudden decrease is suggestive of the beginning of an attack of gout, and its well-established decrease or suppression marks damaged kidneys. Mucus again is always more or less present, representing as it does the epithelium *débris* of the urinary passages. This, and the presence of micro-organisms are the causes of urine turning cloudy and ammoniacal after it has stood some time. If present in increased proportions, they give evidence of a catarrhal or eroding condition of the said passages, and in consequence the urine turns cloudy and ammoniacal even before it leaves the bladder. You should accustom yourselves to notice differences in transparency, in colour, and in odour; and when in charge, report such changes as they occur. Bile, when abundant, gives to urine a colour as dark as porter, but when of small amount it only raises the orange tone. Blood turns urine red or smoky, according to quantity, freshness, or origin. Mucus and pus produce thick cloudy effects. Phosphates, which only fall when the urine is alkaline, give a whitish deposit, while urates furnish yellow, white, or red, sandlike ones, but absolute certainty as to the nature and cause of differences can only be gained by appropriate chemical tests, or by the use of the microscope. For instance, bile in small quantities might be overlooked, and the increased colour attributed to something else, till on testing with a solution of iodine, its presence is proved by the urine turning a light green. Equally, mucus and pus might be mistaken for each other, till liquor potassæ or ozonic ether tests are applied, or the microscope is used. Liquor potassæ thickens pus and liquefies mucus, and ozonic ether effervesces with pus. Further, certain drugs when taken so much affect the colour and odour of urine that a mistaken impression might be gained unless tests were applied, or it was known that such drugs were being used.

As bearing on the importance of "Urinary Evidence," I propose to-day to speak to you of the albuminuria of Bright's disease, or nephritis, that is inflammation of the kidneys, and of glycosuria or sugar in the urine of diabetes; also of the exciting causes of these striking and, alas, too often fatal, maladies.

Nephritis is the outcome of actual disease in the kidneys, while diabetes, though marked by a morbid constituent in the urine, is independent of any such origin. But before going further, let us consider what are the offices of the kidneys, and how their structure, when intact, adapts them to the fulfilment of those offices.

The excretion of urine is a double process—in part one of filtration, as effected by means of the glomeruli tufts, influenced by blood-pressure, and in part one of excretion, as effected by the epithelial cells of the renal tubules. These tubules are surrounded and pressed upon by a network of veins and capillaries, and are stimulated by substances drawn into them from the blood, substances which, after the nature of glands, they convert into chemical compounds. Filtration tends to the removal of water and of some solids, though thanks to the repeated curves of the renal tubules in some of their parts, the flow of water is sufficiently retarded to permit of its re-absorption and storage, while the secreting cells at the same time seem mainly to do the work of eliminating waste-products, the retention of which have so poisoning an effect. You will understand this

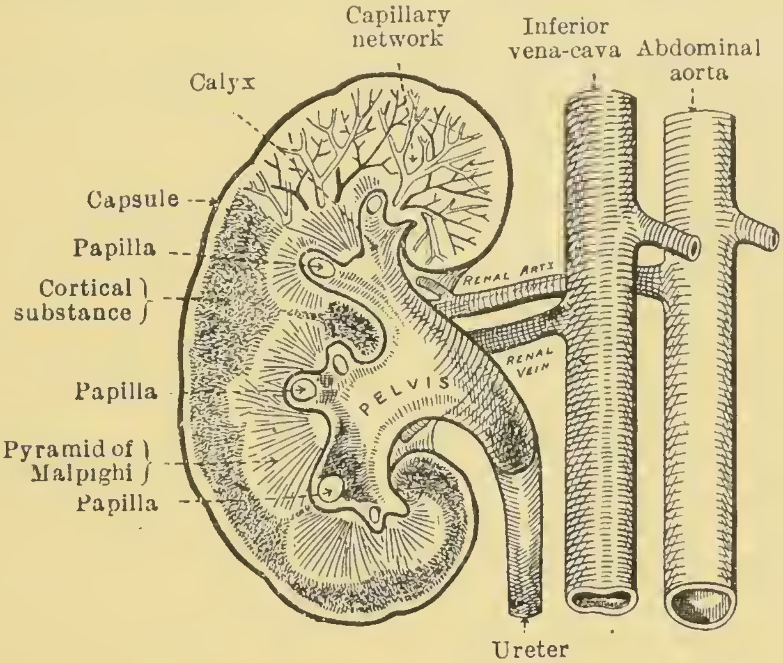

Fig. 9.—Vertical section through right kidney (seen from the front.)

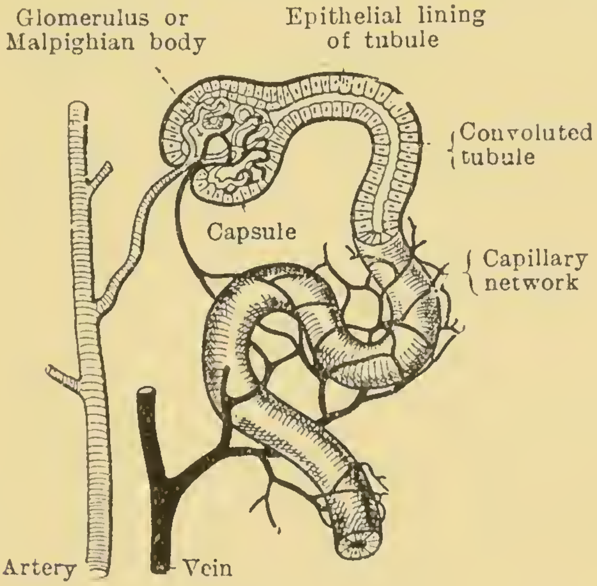

Fig. 10.—Minute structure of kidney.

(From Warwick & Tunstall's "First-Aid to the Injured and Sick.")

work of secretion if you remember the law of osmosis, viz., how the delicate membranes of animal cells allow fluids, gases, and even very fine solids to push out and in of them without their rupturing. You also will understand the working of the chemical elaboration performed by the secreting epithelial cells, if you remember what happens in all healthy, blood-supplied, secreting glands, viz., how they cast off their cells or the contents of their cells into the secretion which it is their special office to form—be it bile, milk, or gastric juices, etc., and that for every cell lost a fresh one arises.

The work of the kidneys in this double process of filtration and of secretion is, as we have seen, threefold, viz., first, rapid removal of water from the body; second, elimination of the waste-products; and third, storage of a certain amount of water for future use after it has done its flushing-out work.

The structure of the kidneys, when intact, is wonderfully adapted to this threefold work; for these organs, though small, are composed of innumerable minute tubes and tubules packed together by a little connective tissue, and they are supplied to an exceptional extent with blood-vessels—partly single arteries and veins with single branches, partly close plexus, and lastly with numerous capsule-covered tufts, where arteries end and veins begin. These tufts (glomeruli) might be compared to so many blood-and-water-filled little sponges, pressure on which causes their contents to exude into the funnel-like capsules in which they lie, and into each of which is inserted one of the extremities of a renal tubule. The exuded fluid is carried off by these tiny drain pipes into the basin, or pelvis, of the kidney, whence it passes out by a much larger main pipe—the ureter—of which there is one for each kidney, on into the bladder—the urine reservoir. (See *Figs*. 9, 10.)

BRIGHT'S DISEASE (NEPHRITIS).

Under this head it is usual to include only those diseases of the kidneys which, while they disintegrate and structurally damage the tissues through inflammation, do not result in actual suppuration, as happens consequent on obstruction by calculi, either in the body of the kidneys or in the urinary passages, or where there are new growths. According to which of the component tissues is the one chiefly, or primarily affected, nephritis is spoken of as being "*tubal,*" when the epithelium of the renal tubules is involved; "*waxy or degenerative,*" when affecting the arteries: "*interstitial,*" when affecting the connective tissue and so leading to an invading development of connective tissue and of fibroid contractions; and lastly, as "*glomerular*" from its involving the glomeruli. But in truth, more than one, if not all of these, are commonly involved, some one, at least at the commencement, being more specially so.

ALBUMINURIA.

Albumin in the urine is a symptom common to all forms of Bright's disease in all their stages, though the amount is much greater in some cases than in others.* Another symptom proper to the later stages of most cases of nephritis, though also to be seen in the earlier stages, is a decrease in or even a suppression of the urine, that leads to uræmia, or blood poisoning; and a third symptom rarely absent in the majority of established cases, is the presence in the urine of casts or moulds of the tubules, lining cells, and of some of the epithelial cells themselves. These microscopic casts are sometimes transparent—"hyaline," or composed of albuminoid substances. In other cases they are "fatty," or "bloody" or "granular," the first mostly prevailing in advanced stages of nephritis, betokening serious changes, or wearing down of the renal machinery. Sometimes two or more kinds are found in the urine of nephritic patients.

Recovery or improvement only comes where there is decrease of albumin and disappearance of casts, along with a return to a normal amount of urine: so you will understand with what interest doctors watch fluctuations, and how important it is to have accurate and constant reports as to the quantity and composition of urine in nephritis cases as guides for treatment and as throwing light on the probable course or termination of the disease. Without the microscope you cannot make out much about the casts, but you can easily ascertain whether albumin is present or absent by heating some of the suspected urine. If albumin is present the urine will turn opaque, and a white precipitate will fall to the bottom. As, however, the white precipitate might be phosphates, it is right to add some drops of nitric acid, which dissolves phosphates but does not dissolve albumin. In cases where the proportion of albumin is exceedingly high, the whole of such a specimen will coagulate so completely that the full test-tube can be turned upside down and no liquid escape. To calculate the amount of albumin, take three drops of pure nitric acid to one ounce of the urine collected in twenty-four hours; boil, and allow it to stand for twenty-four hours in a graduated glass with its mouth filled with cotton-wool. All albumin present will separate and fall as a thick white deposit, and you can establish the proportion of albumin by comparing the amount of this "deposit" indicated on the glass, as against the ounce of urine experimented with. By repeating this test at intervals, you get the rise or decrease of albumin to the ounce. Another rough-and-ready way of proving the presence or absence of albumin, is to pour a considerable quantity of urine into a vessel, and shake till it froths. If at the end of several hours froth is still to be seen, albumin is present. This plan would not suffice for the detection of albumin in very small quantities, nor determine any trifling variations of amount from day to day or from week to week. For these, doctors have more elaborate and accurate tests.*

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* With "granular" kidney, unless acutely inflamed, there is usually less albumin than with "large white kidney," and less dropsy, but more prominent uræmic symptoms.

There is no Bright's disease without albuminuria, but albuminuria by no means always implies disease of the kidneys. First, there is albumin which is not true serum albumin. The false (or hetero) albumin may come from eating a large quantity of the white of eggs, or from a fit of indigestion, the albumin of the food passing unaltered into the urine (it being apparently more diffusible than serum albumin). Secondly, there is the albumin derived from pus or blood, which has not its source in the kidneys. Thirdly, there is what is known as transitory or functional albuminuria, occurring during or after fevers or other severe illnesses, or during pregnancy, or even, in some persons, after exercise.

As to casts, they are undeniable danger signals, because they clearly indicate that the renal tubules are being constantly plugged and their linings being worn off.† Hence come obstruction to drainage and an enfeebled secretion, or, in other words, water and waste-products are imperfectly eliminated. Consequently, the probability is that, unless the lesion be repaired, the essential offices of the kidneys will be less and less efficiently carried out. Presently, if such conditions continue, dropsy, uræmia, and in some cases very marked anæmia will make their appearance, especially so in acute nephritis. In acute nephritis, dropsy begins in the eyelids and face, and passes on to the rest of the body: wherein it differs from cardiac dropsy, which usually begins in the extremities, though at times in the trunk. Sometimes the dropsy of nephritis spreads to an enormous extent, demanding tapping, and placing the patient's life in jeopardy if it invades the pleura or pericardium; while extremes of uræmia will produce convulsions or coma, in which the patient may die. Much can, however, be done to reduce these symptoms, and a large proportion of cases do recover, some completely, others only to pass into chronic nephritis. Such may live on for a few months, or for many years. Some rally from the most alarming conditions, but too commonly with them the sentence of death is only postponed for a short time. As it is in acute nephritis, or in the last stages of chronic forms of Bright's disease, that your services as nurses would be required, I will speak only of those phases of the diseases.

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* Paper tests which facilitate bedside investigations for the detection of both albumin and sugar were introduced by Dr. G. Oliver. For the detection of albumin: mercury and ferrocyanide, along with acetic acid paper; and for proving proportion, a piece of ground glass of standard opacity, with a card on which are lines of different thicknesses.

† Epithelial casts mark independent disease of the kidney, whereas hyaline casts may be a heart symptom caused by increased intravenous blood pressure forcing albumin through the membrane, the pores of which get widened through the continuous blood-pressure which allows that to pass which normally would not pass, viz., albumin: but unless there were also strong intra-arterial pressure this would not happen.

The treatment of acute nephritis is entirely directed to resting the kidneys and to drawing away the blood from them. Rest is secured by allowing the patient very little or no nitrogenous food (some doctors limit their patients in the first few days to water gruel, others allow milk), and by the use of certain drugs, such as pilocarpine, which induce profuse perspiration, and of hot-air baths, thus forcing the bowels and the skin to do the work of the kidneys. Hot fomentations, or cupping across the loins are employed to draw the blood to the surface. To administer the hot-air baths and to prevent the patient feeling chilly would be your business; and should the patient develop convulsions, such as differ little from those of epilepsy, you must have something ready to put between the teeth immediately in order to prevent the patient's tongue being bitten. Possibly, also, in order to relieve the spasms of these convulsions, the doctor may direct you to give occasional inhalations of chloroform. A patient in such a condition is a painful spectacle that is very trying to the nerves; but here, as in ghastly operations, you will find that close attention to the details of your work steadies the nerves. If instead of convulsions or coma, uræmic poisoning may excite fits of delirium, usually most marked at those periods when the body is generally relieved, the management of such sufferers will demand from you great presence of mind and tact. Never allow the patient to notice your return to his room or his side, or he may "go for you"; and when you have to be near him, keep if possible rather behind his shoulder and quite close, so that should he strike out he may not hurt you. If you wear glasses, bear in mind that the flash of a candle across spectacles has a most enraging effect on a delirious person. Ice bags applied to the back of the neck are quieting in such cases.*

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* In your attendance on pregnant or lying-in women you may come across a case of convulsions of nephritic origin, called when occurring under such circumstances, "Eclampsia," but as this enters into your obstetrical studies, I do not dwell upon eclampsia just now.

Patients in advanced stages of chronic nephritis* require serious nursing, if rendered helpless by the weight of the dropsy or heart weakness, or when suffering from any of the serious complications which follow on Bright's disease, and which often hasten the end, such as inflammation or œdema of the lungs, intractable diarrhœa, or apoplexy.

Chronic nephritis—not following on the subsidence of acute nephritis, nor on well-established heart disease, nor on scarlet fever,† which is so fruitful a cause, and when it might have been feared—often exists for a considerable time without the sufferer being aware of it.‡ Having to rise in the night, or possibly an unaccountable failure of eyesight, first attracts attention and causes a man to seek advice. Then the detection of albumin and of casts in the urine establishes the ominous fact.

The failure of eyesight in Bright's disease may be due to hæmorrhage on the retina,‖ caused by the high blood-pressure proper to this disease, or by dilatation or valvular insufficiency; and it is this arterial tension which explains the appearance of patches of purpura (or extravasation of blood under the skin), the constant fits of bleeding from the nose (epistaxis), or at last in such patients apoplexy, which is, as you know, due to the rupture of a blood-vessel in or on the brain. High blood-pressure, or strong tension, is due in these cases to a contraction of the arterioles and capillaries that obstructs the passage of the blood in, or through them into, the veins, which obstruction has to be overcome by unusually strong expelling contractions of the heart (more pressure has to be put on by the force pump). This constitutes a tax on the heart and a strain on the blood-vessels. The former at first acquires compensation and increased force through hypertrophy, but the vessels suffer from the strain, and with their tendency to degenerate they become liable to rupture. In time hypertrophy reaches its limits, or the heart being damaged, perfect circulation of the blood can no longer be maintained, and then every bad symptom, the risk of hæmorrhage excepted, becomes exaggerated and a fatal termination is inevitable.

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* As the advanced stages of chronic tubal nephritis and cirrhosis of the kidneys have so much resemblance, I have permitted myself to speak of some of these symptoms indifferently. Continuance of tubal nephritis leads to an atrophied contracted granular state of the kidney. Interstitial nephritis is the result of cirrhosis of the kidneys, though the process is a different one.

† In the nephritis due to scarlet fever there is often blood in the urine, which helps to draw the patient's attention to his condition.

‡ Especially in interstitial nephritis with gout as an exciting cause.

‖ A commoner affection of the eyes in Bright's disease is what is known as "albuminuric retinitis"—a peculiar form of inflammation of the retina causing great imperfection of the sight.

SUBJECT II continued.—LECTURE 2

GLYCOSURIA AND DIABETES

DIABETES mellitus is characterized by the passage of abnormally large quantities of urine (10 to 20 pints per day) and by the presence in the urine of an abnormal constituent—sugar (glucose), amounting sometimes to 6000–7000 grains a day. Yet diabetes mellitus is not in itself a disease of the kidneys: they merely fulfil the part of filters to carry sugar from the blood. In health sugar is present in the blood in a very small percentage, but is never found in the urine except in disease or under certain passing unfavourable conditions, when it may be indicative of glycosuria rather than of true diabetes, and as such may be transitory or easily curable, just as we saw there may be functional or transitory albuminuria apart from the permanent true albuminuria of nephritis.

As to the causation of this commonly fatal disease, in spite of centuries of research much remains still to be ascertained before a tenable theory can be adduced to explain the many puzzles it presents. Why the presence of sugar in the urine? Is it due to over-production or to its non-consumption, i.e., non-reduction by the tissues and lungs to carbonic acid and water as happens in health; or to some other imperfect transformation of compounds? What is the poison which produces the well-known symptoms of the worst cases of diabetes—boils and carbuncles, loss of teeth and hair, strawberry colour of the blood, tendencies to gangrene and decomposition; and finally, that deadly coma which marks the close of diabetes, with its strange respiratory movements (not to be accounted for by any affection of the lungs)? Why the passing of such quantities of urine (polyuria)? The last point can scarcely be accounted for on the ground that an extra amount of fluid is called for to carry off the sugar, seeing that a like excess prevails in the rarer diabetes insipidus, where no sugar has to be eliminated. Though polyuria is common to both, probably quite different agents influence the two diseases. Many of the latest researches seem to point to nerve influences as the exciting cause of polyuria. Just as nerve influences on the blood-vessels of the liver create disturbances or failure in the ordinary functions of that organ, so failure in other organs may influence the perfect conversion of sugar. In health there are, first, the conversion of the sugar of food materials in the stomach and intestines into a less diffusible form of sugar—glycogen; secondly, the storing of glycogen in the hepatic cells to be given out as required for use in the blood-tissues where, through the agency of a ferment (diastase), it is converted back into glucose and grape sugar. As such it readily oxidizes, and in health is reduced to carbonic acid and water, thus being disposed of before it reaches the kidneys.

All the outward miserable symptoms of diabetes are to be found most vividly set forth in the works of a celebrated Roman physician as far back as the beginning of the first Christian century; but what we now regard as its characterizing feature, namely, the presence of sugar in the urine, was first detected by an Englishman, Thomas Willis, as late as 1674. The next important advances towards discovering the cause of this disease were made when Charles Bernard, a Frenchman, artificially induced glycosuria by puncturing the 4th ventricle of the brain, thus proving the power of nerve influence, and when he also demonstrated the glycogen-forming function of the liver by other experiments. Later investigators showed that removal of the pancreas likewise produces glycosuria.

Still remoter causes, however, are indicated by a German (Ebstein), who about twenty years ago started the theory, and by right of his experiments held it proved, that diabetes results from an insufficient supply of carbonic acid in the blood, teaching that carbonic acid is the natural check or counter-influence to the action of the diastatic ferment; and that when lacking, that ferment then converts glycogen all too rapidly to allow of the sugar being absorbed into the tissues from the blood, and consequently of getting reduced by them and the lungs into carbonic acid and water before it reaches the kidneys. Hence, instead of serving as a nutritive and heat-producing constituent, sugar is cast out by the kidneys as waste and is lost to the body, except as a poison. Further, he and his follower, Dr. Schnee, ascribe insufficient supply of carbonic acid in the body to a fault in the protoplasm, the latter attributing his cures of true diabetes—not merely cases of glycosuria (he makes a great difference between the two)—to his treating the former as "a hereditary and constitutional taint arising from degeneracy of the protoplasm."

Now let us turn to the symptoms and course of well-developed and fatal cases of true diabetes, those being the ones you are likely to attend as nurses.

Diabetes is far commoner in men than in women, and is much more acute and rapidly fatal in young than in elderly persons, for the latter are better influenced by special diet, and for them nowadays ameliorations, if not positive recoveries, can often be secured.

The beginning of diabetes is sometimes unnoticed, but ere long its two characteristic symptoms, a copious drinking of fluids, and a frequent and abundant passage of highly sugar-charged urine, excite attention. The specific gravity of the urine rises rapidly, possibly reaching 1070, and even higher rates have been recorded. The urine is of a pale straw colour, with an odour of damp hay or of stored apples, and the breath, too, especially in the coma stage, has that same odour, or one like chloroform. The urine, when heated in a test tube smells like burnt sugar, and drops of it spilt on cloth show white crystalline deposits.

A great many ready-made chemical tests, bearing the names of their inventors, can be obtained for testing the presence or absence of sugar, but a simple test is to evaporate the urine, when, should the residue be soluble in water or alcohol, sugar is present. To ascertain the relative proportion of sugar to a given quantity of urine, picric acid and yeast are often used. The latter test you can easily apply. Fill two bottles with the suspected urine, and put a small quantity of yeast into one of them. Weigh, and register the weight of each before setting aside for some hours in a cool place. Then re-weigh the bottle containing the yeast. Any difference between its present and its previous weight, or between the two bottles, gives the amount of sugar destroyed by fermentation through conversion of the sugar into alcohol and carbonic acid by the yeast.

As there are considerable variations in the relative amount of sugar in urine passed at different times of the day, doctors often direct the urine of the twenty-four hours to be collected and a mixed sample to be supplied to them. Taking this as an average, they calculate from week to week or from day to day, as the case may be, what is the increase or the decrease of sugar indicated by these samples, and form their opinion of the patient's progress, and order diet and treatment accordingly. Great hunger, though not quite so unfailing a symptom as great thirst, is a very usual one; and yet, in spite of all the food consumed, the patients waste rapidly, though occasionally fat patients become fatter while growing weaker. A nurse may find it no easy matter to restrain a diabetic patient from swallowing all the fluids he can lay hands on, or to satisfy him with the special anti-diabetic diet ordered, which generally excludes all food materials containing starch or sugar, such as ordinary bread, rice, arrowroot, sago, tapioca; all mealy vegetables, as potatoes, peas and beans; all fruits, fresh or preserved; beer and sparkling wines, and even milk, except in very small quantities. This leaves for use, meat, fish, eggs, and gluten bread; but in many cases the patient cannot bear so highly nitrogenous a diet, and some, even on it, continue to secrete sugar.

Of drugs, opium, especially its alkaloids, morphia and codeine in ever-increasing doses, are well tolerated, and in some cases bring about decrease of sugar; while alkalies, especially in the waters of Contrexéville and Carlsbad, have proved beneficial, at least in glycosuria if not in true diabetes.

In diabetes the tongue and lips suffer. The tongue cracks and looks "beefy," the lips get dry, while the saliva becomes sour and scanty. Cataract and other affections of the eyes, boils and carbuncles, and, in women, obstinate pruritus, may occur in this cruel malady. In some cases there will be excruciating nerve pains, in others loss of sensibility, and in others, during the course of the disease, the kidneys or liver become involved, giving rise to further complications. Coma in its beginning is sometimes marked by abdominal pains, and at first may be lingering, but oftenest, especially if following on fatigue, chill, or extreme excitement, it is sudden and rapid in its course. Unlike the coma of uræmia, there are rarely convulsions or wild fits of delirium, but there is proper to it a peculiar low, deep, sighing breathing, sometimes described as "air hunger," because not to be explained by the presence of anything abnormal in the chest.

A large proportion of sufferers from diabetes develop pneumonia or phthisis, from which they have little or no chance of recovering, and then they require all the care and close nursing these exhausting conditions demand.

SUBJECT III

THE PROCESSES OF DIGESTION

Lecture I

THE ORGANS AND COURSE OF DIGESTION—EFFECTS OF DIET

Those manifold processes of digestion which work to supply nourishment for the maintenance of the body, are carried on mechanically and chemically within the different parts of the alimentary tract, where solid and other foods are so changed in character that their absorption by the tiny tissue cells, via the blood, is rendered possible. But though the nourishment of the body so greatly depends on the processes of digestion being well carried out, still more essential is it that only fitting materials should be offered to the digestion whereon to work out that amazing miracle, the converting of dead matter into living substances.

Like most people not afflicted with a delicate digestion, you probably do not select what you eat according to any recognized principle, but according to your own, or your neighbour's, habits. This often may be all very well, but for our present purpose let us look for a somewhat wider principle : let us inquire why it is good to eat certain things and not others, and not wise to live solely on some one article of food except, in certain circumstances, on milk. Unless the food materials consumed contain certain chemical elements and compounds, and in the same proportion as those which go to make the blood and solid tissues of the body, they cannot serve, or at least cannot suffice, to supply the nourishment needed to replace what the body daily loses through voluntary and involuntary activities, and through the heat which all living bodies give off. This principle of employing for repairs only such materials as are in every respect similar to those which compose the article to be repaired, rules not only in animate Nature but in everyday practice. Let us take the case of a well-advised needlewoman entrusted with the repair of an old piece of tapestry, worn in places by friction, and moth-eaten in others. She will reject silk and linen threads, however well they may suit in colour, and will seek for woollen ones. If those she finds prove too thick, she will carefully reduce them by so many ply, or if stiff from overdressing, will soak them in water, or soften them in some other way, and will avoid making too many stitches, so that the parts repaired shall not be heavier than the rest of the tapestry. If the piece to be repaired represents part of some kingly or state processional robe, with its glow of jewels and gold and silver, many and varied will be the threads she will have to find and use : yet their number in such a case would be as nothing compared with the numberless elements and compounds which compose our living garment, and which are needed to repair it.

Into the composition of the human body there enter fourteen chemical elements in ever-changing compounds, some inorganic (or mineral), the rest organic (that is, containing carbon). Of these fourteen elements, carbon, oxygen, hydrogen, and nitrogen constitute 85 per cent of the whole, the other ten being small in quantity, though important as the agents which assist in breaking up and transforming the various chemical compounds. Amongst minerals and their compounds, besides common salt (chloride of sodium), are potash, soda, the salts of iron, sulphates, phosphates, and calcium, etc. As to the organic compounds, their number is very great, the most important being proteids in their various classes, the closely allied albuminoids and carbohydrates, and fats. Proteids contain carbon, oxygen, hydrogen, and nitrogen, combined with sulphur, and sometimes with phosphorus and iron. They are invariably present in living cells, and occur in a viscid condition in connection with all the solid tissues of the body. In some vegetables, proteids form a larger part of their composition than they do in animal frames. For example, beans and lentils contain rather more nitrogenous matter than does lean beef, and, owing to the amount of carbon they also contain, they supply us with a truly nourishing food. Both carbohydrates and fats, unlike proteids, lack nitrogen, and fats differ from carbohydrates in that they have a smaller proportion of oxygen to hydrogen.

Carbohydrates prevail more largely in the vegetable than in the animal kingdom. Their leading representatives are starch and different kinds of sugar, with their derivatives and intermediate products, and it is as these that sugar finds a place in the human body, as for example in liver-stored glycogen, to which the name of "animal starch" is sometimes given. Fats are to be found for the seeking, not only in the animal and vegetable kingdoms, but also in the mineral world as oils. Oils, as you know, are also found in some plants, such as olives, nuts of all kinds, and the castor-oil plant, while in such ordinary articles of food as cream, butter, and bacon, we find plenty of animal fat wherewith to enable us to increase, or to keep up, bodily adipose matter.

The principal constituents of the blood are the five following: albumin, fibrin, fat, salts, and water. Though each does not individually contain carbon, oxygen, hydrogen, and nitrogen, well combined they make the blood an enriching food for the tissues. Even so should it be with the food we consume, for it is only by a judiciously selected combination—one article of diet supplying what another lacks in some alimentary, or, as called by some writers, proximate principle—that the balance can be maintained. The daily loss of nitrogen by the kidneys is so considerable, that obviously our food material should ensure a proportionately large supply of nitrogen; and further, to compensate for the constant loss of carbon—required to maintain the heat of the body—we should eat what will at least replace the carbon lost, and furnish fresh fuel, as it were, for our tissue furnaces. The average loss of nitrogen is usually put at 300 gr. daily, and that of carbon at the far higher figure of 4000 gr.

Let us see how these losses can be best, and at the same time most economically, made good. If bread, which contains only one in eighty of nitrogen, were the sole food eaten, a fatiguing amount would have to be consumed in order to furnish the quantity of nitrogen required to maintain the standard of flesh-making proteids. If on the contrary, lean meat, which contains a very small proportion of carbon, formed the sole dietary, an extravagant quantity would have to be eaten in order to replace the lost 4000 gr. of carbon. There is only one article of food which in itself supplies all the requisite alimentary principles, and in their proper proportion, and that is milk. In milk, carbohydrates are represented by the sugar it contains—milk sugar; fats by the butter it yields, and proteids by the casein, that goes to make cheese. Eggs are nearly as perfect a foodstuff as milk, and the same might be said of cheese, beans, and lentils, were it not that in them fats are not sufficiently represented. As an illustration of this subject, let me remind you how differently the men in towns besieged during the Boer War were affected owing to the various dietary conditions in the towns. In Ladysmith, where latterly little but meat was to be had, the besieged, when at last relieved, presented a sadly emaciated appearance, whereas in Kimberley, where the statutory rations, though small, included Kaffir mealies, the appearance of the men by no means suggested starvation. Other examples may be seen any day in patients undergoing the well-known, and often successful, Salisbury treatment for rheumatism, etc. They are given only lean beef to eat and much hot water to drink, and as a rule they lose flesh heavily. For thin persons it is, to say the least, a trying treatment, while those capable of eating enough beef to prevent loss of flesh, are not likely to overtax their kidneys by consuming so much nitrogenous food, for the work of eliminating the waste products of the proteids of nitrogenous foodstuffs lies with the kidneys.

Let us leave for the present the consideration of the respective values of different articles of food, and see how digestion deals with good food materials, by which I mean materials containing alimentary principles corresponding in their composition to the elements and compounds of which the human body is composed.

Digestion begins in the mouth, where the food if solid is masticated—that is to say, bitten by the teeth and pressed by the tongue against the hard palate till it is more or less torn up; while at the same time it is softened by the saliva which flows from three double sets of salivary glands, situated under the tongue, at each end of the lower jaw (*Fig.* 11). Saliva contains amongst other things a ferment known as ptyalin, which, acting on the starch farinaceous matter contains, converts it into maltose, a form of sugar akin to cane sugar—that is to say, it does this if sufficient time is allowed for the process of conversion in its different stages to be carried out—while mucin, another salivary constituent, along with the water of the saliva, serves to lubricate the surface of the pharynx and gullet, and so to facilitate the downward passage of the softened bolus into the stomach. You must not, however, suppose that the bolus drops down the gullet as it would down a smooth upright tube. It is drawn downwards by a succession of undulatory movements on the part of the embracing circular muscles of the gullet, to where its summoning contact and pressure enable it to force its way through the sphincter-like ring of the gullet into the cardiac entrance of the stomach. There more coercive handling and a number of transforming agents await it, for besides being pro-

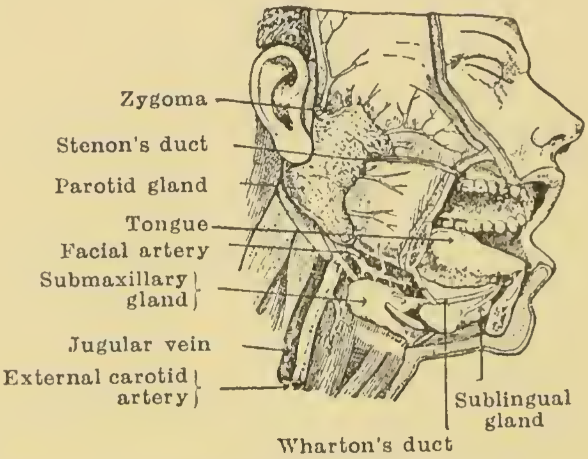

Fig. 11.—Face dissected to show the mouth and salivary glands.

(*From Warwick and Tunstall's "First Aid to the Injured and Sick."*)

pelled onwards into the intestines through the pylorus, or intestinal outlet of the stomach, the many-coated walls of the stomach subject it to strong compression, and churn and roll it about, so that it is constantly brought into direct contact with the secreting glands and glandular cells with which the mucous membrane of that organ is closely covered. These glands are active only when stimulated by the presence of food in the stomach, but so well do they then work that the amount of gastric juice secreted daily is said to be not less than from 10 to 20 pints.

The three principal constituents of the gastric juice are pepsin, hydrochloric acid, and water. Pepsin, by a number of intermediate stages, and aided by the hydrochloric acid, converts insoluble proteids into soluble and highly diffusible peptones, which enter the blood capillaries in the mucous coat of the stomach, and by them pass downwards into the general circulation, but not before they have been carried to the liver, where further conversions and reconversions take place.

It is thought that ptyalin, pepsin, and the other ferments of which I have yet to speak, transform the substances on which they act by making the molecules of the said substances take up one or more molecules of water. The resulting molecules then break up into less complex bodies, while at the same time substances, such as some proteids, which prior to this change had been insoluble in water, become soluble. No fuller explanation of the action of these ferments has yet been arrived at, but it has been ascertained that, though they are powerful transforming agents, they do not share in the transformations they produce, nor do they grow less from working ; but it is also proved that they cease to work when the subject-matter presented to them is excessive, showing that there is a limit to their activities, or as we might say in the language of to-day, they limit their piecework. This peculiarity in gastric ferments might sometimes entail inadequate treatment of what enters and accumulates in the stomach, say during a substantial meal with its different courses, were it not for the controlling action of a somewhat sphincter-like and division-forming stricture, structurally due to the thickening of the fibres of the circular layer of the muscular coat of the stomach. This movable stricture has the effect of converting about two-thirds of the space in the interior of the stomach more or less into a reservoir where the ingesta can be detained till later it is passed on at intervals in limited portions into the remaining space in front of the pylorus. In that less extensive but muscularly stronger part of the stomach, each succeeding portion is so thoroughly churned and dissolved that it is reduced to a semi-fluid grey mass known as chyme, which is then squirted little by little, by the sharply-opening and sharply-closing pylorus, into the head of the duodenum (upper division of the small intestine).

The duodenum is a veritable chemical laboratory, for not only does its mucous membrane secrete many active dissolving agents, but the liver by its common duct pours bile into it, and three different pancreatic ferments reach it from the pancreas by a duct which enters at the same spot as the bile-duct. Of these three ferments, it is steapsin, aided by bile acids, that acts on fats, which are little or not at all changed in the stomach, and splits them up. The outcome is a fine emulsion, with fat droplets, which under the influence of the alkaline secretions of the membrane of the small intestine is turned into soap. The changed fats can then pass through the cells of the epithelial covering of the villi (those tiny projecting processes with which the whole of the mucous membrane of the small intestine is closely studded, giving it a velvety appearance) on into the accompanying lymph-vessels, or lacteals as they are now called by reason of the milk-like material—the chyle—with which they become distended after a meal. The chyle, like lymph in ordinary lymph-vessels, finally obtains entrance into the general circulation at the left jugular vein, brought thither by the many-branched great thoracic duct.

On proteids the pancreatic ferment trypsin acts more powerfully than does pepsin, for not only, like pepsin, does it convert them into peptones, but it produces further changes that go to reduce peptones into simpler organic bodies. The last so produced is the one that reaches the liver from the blood-vessels of the intestinal basement membrane, and which is thought to be carbonate of ammonium ; and it is in the hepatic cells that a final conversion of proteids into urea—the end-product of nitrogenous material—is brought about. From the liver, urea is taken up by the hepatic vein, and so passes into the general circulation, to be ultimately eliminated as one of the waste products of the body by the kidneys, along with otherwise-produced urea.

The work of rendering different kinds of sugar more soluble and of converting starch into sugar, is begun in the mouth by the action of ptyalin, but is rarely completely carried out there, nor is this work advanced in the stomach owing to the opposing acid which gastric juice contains ; hence it has to wait for any advance towards completion through intermediate stages till transferred to the small intestine. There a starch-splitting ferment supplied by the pancreas, combined with the alkaline juices of the intestine, works to produce dextrose, or cane sugar, which is capable of passing into the blood-vessels of the intestinal basement membrane, whence it is carried by the portal vein to the liver where it is stored, not however as sugar, but as glycogen, to be reconverted by the action of the liver cells into sugar. As such, when digestion is not going on, it is given off into the blood to feed the tissues. This sugar is so completely used up by the tissues, more especially by the muscular ones, that none, or almost none, can be found in the blood, or passes into the urine, except in diabetic patients, whose urine sometimes contains a large quantity of sugar. As yet no convincing explanation of this abnormal condition has been established. Some investigators believe it to be due to a failure in the working of the liver cells ; others to insufficiency of the pancreatic ferments (seeing that the removal of, or a severe injury to, the pancreas may lead to diabetes), while the theory of a more modern teacher, Dr. Schnee, is that an oversupply of sugar reaches the blood by reason of a too rapid conversion of glycogen into sugar, owing to the supply of carbonic acid being insufficient to check the action of other glycogen-converting ferments.

The liver in the matter of storing glycogen and delivering it to the tissue-feeding blood only when digestion is not going on, might be compared to a careful mother who refuses to allow her children to eat their many Christmas bonbons all at once, letting them have by degrees these harmless, and indeed for healthy children, nourishing sweets, though deleterious when eaten in large quantities or at wrong times. First and last the liver plays a most important part in the work of digestion ; for besides its special functions of secreting bile, producing urea and glycogen, and storing the latter, the liver is thought to protect the blood by diverting from it some of the intermediate compounds of digestion till rendered harmless by further changes.

The greater part of the work of absorbing converted nutritive matter goes on in the small intestine, not chiefly because the processes of digestion are there more actively advanced than they are in the stomach, but rather owing to its great length—some twenty feet. The whole length of its mucous membrane lining is arranged in a series of transverse folds—what a dressmaker would call pleats, and for making which she would have to use three times as much material as for a plain surface. Thus the surface of the small intestine gives room for a far greater number of epithelial cells than would otherwise be the case, and there is room also for various sets of glands. Of the latter there is one set of which you are sure to hear, the so-called " Peyer's patches," situated towards the end of the ileum (the third and last division of the small intestine), because these glands are the usual point of attack of the typhoid fever microbe, and the spot where a resulting ulceration often causes dangerous hæmorrhages or a fatal perforation of the bowel.

Within the stomach itself not much is actually absorbed beyond perhaps partially dissolved salt and sugar, and such proteids as the pepsin and hydrochloric acid of the gastric juice have sufficiently modified. Water is not absorbed, for it passes rapidly on into the duodenum; but alcohol is, and what is more, alcohol taken in small quantities so stimulates gastric action that a more rapid and greater absorption follows, including at times that of various oils, though as a rule fatty matter undergoes little or no change in the stomach. On the other hand, sad is the havoc wrought when alcohol is largely taken, or taken apart from food on an empty stomach, for inevitable damage results from a constant pouring of this fiery fluid on to the delicate and all-important cells of the mucous membrane of the stomach, and hence we cannot wonder that persons who so ill-treat their digestive organs have no desire for wholesome food, and indeed cannot digest the food they eat. With invalids to whom much alcohol is necessary, it should if possible be given in milk, which prevents these evil effects. Drunkards who are wise enough to dilute the spirits they drink with soda water, and to live on milk, survive longer than others who habitually drink undiluted spirits.

The small intestine propels the food it receives and elaborates along its coiled length by a succession of wave-like contractions, which have the passing effect of narrowing one portion after another of the intestinal tube, one part contracting while the part immediately behind it relaxes. This action is known as the peristaltic movement, and is common to the whole of the digestive tract, but is more especially marked in the bowels. These contracting movements produce an effect similar to that produced when you squeeze ointment out of a small compressible tube, the pressure of your finger and thumb on a given part of the tube accomplishing what pressure on pressure of the circular muscular coat of the lesser intestine does on its contents, forcing them onwards, till finally they are passed on into the commencement of the large intestine (the cæcum) through the intervening ileocæcal valve.

Within this wide pouch-like commencement of the large intestine lies a curious and apparently useless tube, from three to six inches long, the appropriately named "appendix vermiformis" (worm-shaped) about which we hear so often in these days, and which frequently has to be removed in order to save sufferers from the results of inflammation and suppuration in it. Considering the position of the appendix, and the facts that it has no outlet, that its channel is not wider than a goose's quill, and that a small intestinal calculus (or anything as small as a lemon-pip) that has got into it and not—by surrounding muscular pressure—been squeezed out by the way it came in, suffices to start inflammation, it is not wonderful that troubles occur, but quite the contrary.

The position and working of the ileocæcal valve are much more happily arranged, for while allowing of a free passage to the fluid contents of the ileum, it completely bars the way to any return. This is a point I wish to impress on you, not merely as an anatomical feature, but as of practical importance in its bearing on the giving of enemas. To give enemas when nothing has passed out of the small intestine through the ileocæcal valve into the large intestine, is worse than useless. They are often demanded by patients who are nervous because for several days there have been no stools, and sometimes I fear thoughtlessly agreed to by the nurse, with the natural result. As a rule it is not difficult to ascertain by touch and sight whether the small intestine is distended or overcharged or not, and whether the colon has remained flat and empty since last emptied. In such event not the largest of enemas can be of the slightest use. Help can come only from the other side of the intestine, as brought about by Nature or by the use of such drugs as colocynth and salines, which promote fluid secretions and so hasten the advance of intestinal contents towards the ileocæcal valve. Free drinking of water or other fluids often helps in simple cases.

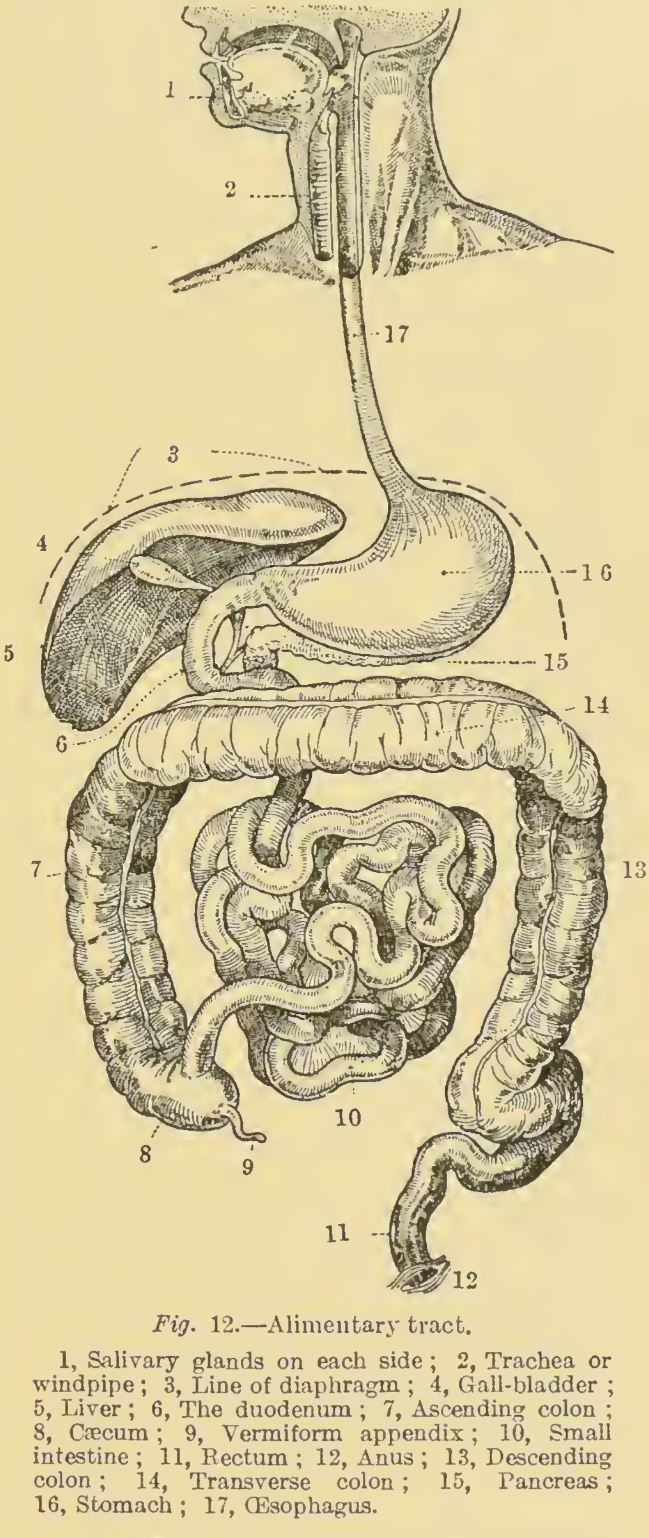

Fig. 12.—Alimentary tract.

1, Salivary glands on each side; 2, Trachea or windpipe; 3, Line of diaphragm; 4, Gall-bladder; 5, Liver; 6, The duodenum; 7, Ascending colon; 8, Cæcum; 9, Vermiform appendix; 10, Small intestine; 11, Rectum; 12, Anus; 13, Descending colon; 14, Transverse colon; 15, Pancreas; 16, Stomach; 17, Œsophagus.

(From Warwick and Tunstall's "First-Aid to the Injured and Sick.")

Though no doubt further digestive changes go on in the large intestine, the fact that its mucous membrane is not provided either with surface-extending transverse folds or with villi, would indicate that the changes are few as compared with those that take place in the small intestine. As to absorption, the absence of villi proves that fats at least are not absorbed. But that water is largely absorbed is certain, seeing that what passes into the larger intestine by the ileocæcal valve is fluid, and that what is propelled along the ascending and transverse portions of the colon, into the descending one, gradually becomes solid and acquires the character and form of the fæces which are expelled at the sphincter-guarded outlet of the intestine—the anus. (See *Fig.* 12.)

Changes of a putrefactive nature are undoubtedly produced in the large intestine by different micro-organisms (bacteria). These bacteria are so numerous as commonly to constitute one-third of the bulk of the fæces, the rest being made up, firstly, of the secretions of the intestine, with their various resulting products (the long list of which I spare you), and secondly, of imperfectly digested or undigestible remainders of the food swallowed. For example, when porridge or whole-oatmeal biscuits are eaten, there will always be a remainder of husks: or if beans, of their skins; and meat may supply a residue in the sheaths of fibres or of small blood-vessels, etc. Whether intestinal bacteria, by reason of the fuller disintegration of animal and vegetable remainders which they bring about by their diastatic and peptonizing ferments, should be regarded as good agents, and whether the gas bred by putrefaction helps to propel and expel the fæces, are debatable points; but it is certain that when the bowels are perforated, and in consequence these inhabitants of the intestines have access to the delicate peritoneum, mortification soon sets in. Further, it is difficult to believe that when such a mass of dead and living bacteria, with their poisonous products, is allowed to remain unduly long in the intestines, harm in some form will not result.

For to-day I must stop, and at another time speak to you further on the processes of digestion and what hinders or helps their work. I have avoided as much as possible the use of chemical terms, as some of you may not have had any opportunity of studying chemistry, but to avoid them altogether is impossible, seeing that digestion is the result mainly of endless chemical reactions.

SUBJECT IV

THE BLOOD

Lecture I

THE COURSE OF THE BLOOD—THE STRUCTURE OF THE HEART

As in next week's lecture I am to speak to you of those diseases and enfeebled conditions of the heart which you may often meet with in your ward patients in their advanced or fatal stages, to-day I propose to devote our time to making sure that you have a clear conception of what is meant by the circulation of the blood. This is necessary, seeing that all diseases of the heart imply disordered circulation ; or conversely, any disorder in the circulation means heart trouble ; hence comes it that if the circulation be markedly or protractedly affected, either sudden death by heart failure, or a diseased condition of some other organ, is likely to be the result. It is therefore essential that your knowledge of the machinery of the heart and of the normal course of the blood through it and the blood-vessels, should be clear enough to enable you to understand why, given certain defects in the heart or in the blood-vessels, or any deviations of the blood from its normal course, suffering and danger must follow.

The blood is propelled by the pumping of the heart, and is distributed all over the body through a series of pipes or tubes. These are of three kinds, each having its own office to fulfil : (1) *The arteries.* Strong and elastic, they bear away blood from the heart, and terminate in (2) *The capillaries.* These minute blood-vessels form a network through and around all the tissues, and out of them rise (3) *The veins,* whose office it is to carry blood back to the heart. The veins increase in size as they approach the heart, while the arteries diminish in size as they pass farther from it. (*Fig.* 13.)

The heart is the centre of action—a very force pump—with a motor power within its contractile muscular fibres, being in truth nothing but a muscular bag. It beats rhythmically and automatically, and at each beat it squeezes out, or discharges, a certain quantity of blood into the two main arteries, the aorta and the pulmonary artery; while during each pause, it receives into its cavities a like quantity of vein-returned blood.

The structure of the heart is complicated. An upright partition (septum) divides it into halves, in each of which are two chambers—an upper and an under—called the auricle and the ventricle. The former is more especially the receiving, and the latter the propelling, cavity. Between each of these chambers are communicating valves, or trap-doors, which, while they allow of the passage of the blood from the upper to the lower chamber, serve to prevent its return; but between the two halves of the heart there is no direct communication, only a circuitous one.

We might roughly compare the heart and the circulation to two covered platforms built back to back within one station, with double lines in common but with no passage through the station itself. Passengers start from platform A on the outgoing lines, journey to the country market-towns, buy and sell, and return exhausted and soiled along the in-coming lines to platform B. The passengers are the red corpuscles which, with the plasma (fluid part), make up the blood. Platform A is the left half of the heart. The out-going lines are the arteries. The market-towns are the capillaries. The in-coming lines are the veins, which conduct the corpuscles to platform B, the right half of the heart.

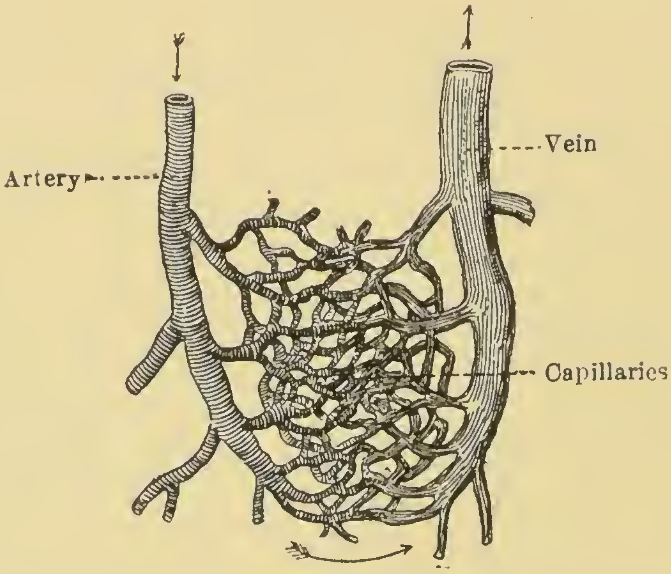

Fig. 13.—Capillaries connecting an artery to a vein.
(The arrows indicate the direction in which the blood flows.)

(From Warwick and Tunstall's "First Aid to the Injured and Sick.")

What happens is this: Dark, unoxygenated blood is poured by the big vena cava into the right auricle. When full, the auricle contracts, and its contents pass through a valve down into the right ventricle, which in its turn contracts, and in so doing expels a certain quantity of blood into the pulmonary artery, driving it along on its way to the capillaries of the lungs. There it absorbs oxygen, and becomes bright red. Thus changed, it is carried by the pulmonary veins to the left auricle of the heart. What happened in the right chambers is repeated simultaneously in those of the left half of the heart, and by means of the contraction of the powerful left ventricle the blood is finally forced into the aorta, the great main artery, and is fairly started on the greater circle through the network of branching arteries, arterioles, and capillaries, to be caught up by branch veins, and at last poured back by the great vena cava into the right auricle whence it started. The course I have just described is called "The Circulation," or "The Systemic Circle," or "The Greater Circle," while the course which directly links the heart and the lungs is called the "Pulmonary Circle" or "The Inner Circle." (See *Fig.* 14.)

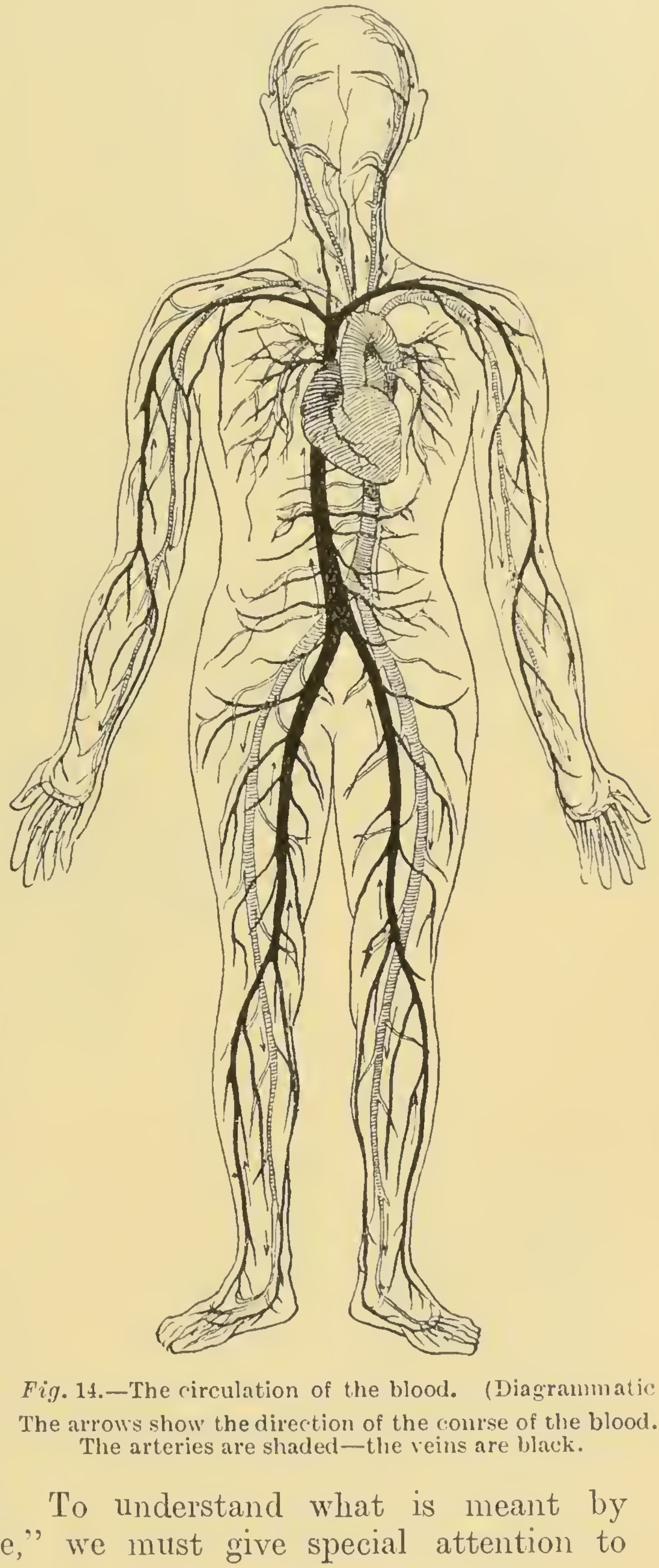

Fig. 14.—The circulation of the blood. (Diagrammatic.) The arrows show the direction of the course of the blood. The arteries are shaded—the veins are black.

Besides the valves or trap-doors between the two chambers, there are also valves at the points where the pulmonary and the aortic arteries carry forth the blood. To understand what is meant by "valvular heart disease," we must give special attention to the nature and machinery of the said valves, inasmuch as they guard the orifices of the heart and regulate the outflow and inflow of the blood, and are as it were the key of the situation.

The two valves between the two chambers of each half of the heart—the mitral in the left and the tricuspid in the right half—afford an onward passage to the blood from auricles to ventricles, and by their accurate closing prevent any backflow into the auricles. The aortic and pulmonary valves at the orifices of the ventricles act a like part by the blood at its exit from the ventricles, but in shape and in kind they differ from the mitral and the tricuspid, being pocket-shaped, and more or less like the valves in veins, which the former are not. Attached at their base to the inner sides of the arteries, their edges project loosely forwards except when a jet of blood is forced into the artery. Then they fill up and get pressed together, so as to present as it were a padded opposing door to any regurgitation (that is, return of blood to whence it came); but in health, they open readily to pressure from the other (ventricular) side.

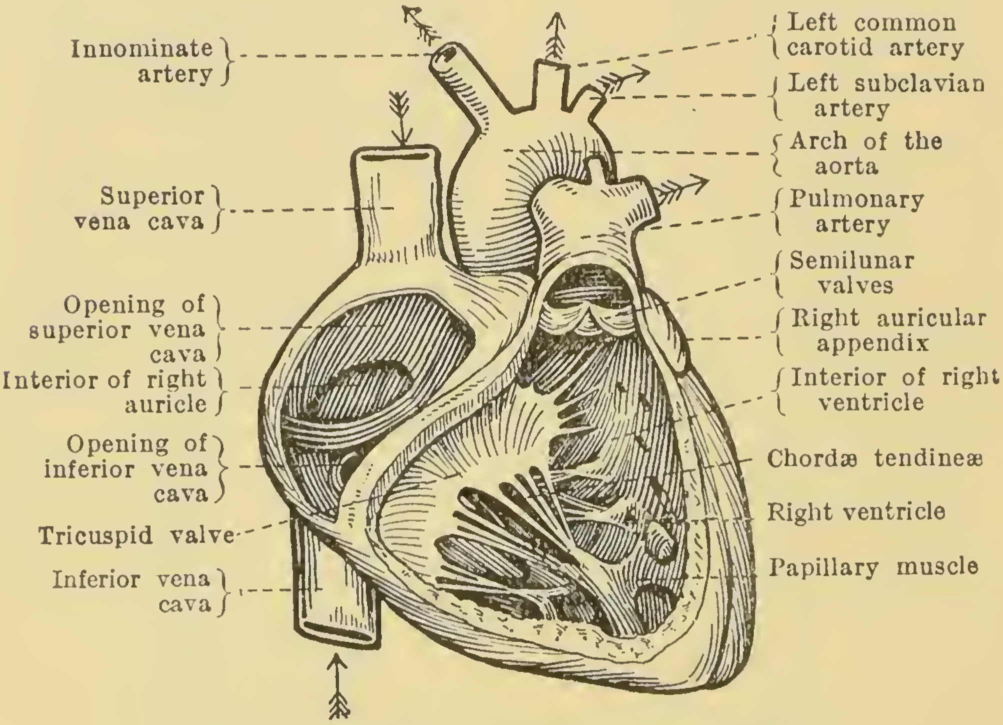

Fig. 15.—Right side of the heart (laid open).
(The arrows indicate the direction in which the blood flows.)

(From Warwick and Tunstall's "First Aid to the Injured and Sick.")

The mitral valve consists of two membranous flaps, the tricuspid of three, and their mechanism is rather more complicated than that of the semilunar cusps of the arteries, and they are more delicate.

The said membranous flaps spring from the edges of the openings like lips from a mouth. At their points of origin they remain unchanged, but their free edges fall backwards against the walls of the chambers (ventricles) whenever the pressure of the blood comes from above and flows across them. When the blood has filled the chamber it then gets in between the flaps and the walls, and floats them up as far as the loose tendinous cords which attach these flaps to the sides of the chamber will permit. These cords only just allow of the flaps being pushed up far enough to meet one another, and no farther; consequently the flaps cannot be forced apart into the auricles. Thus the trap-door is well closed against any return of the blood, but closed only to re-open on each renewed pressure from above of incoming blood. (*Figs.* 15 and 16.) When the mitral, the tricuspid, the pulmonary, or the aortic valve is spoken of as being diseased (valvular disease), it may mean that the valve is imperfect either in its power to close or to open completely. Inability to open completely may be due either to thickening contractions, or to some obstruction, both of which delay the outflow of blood. Incomplete closing allows of blood returning into the chamber from which it issued, and has also other effects. Not infrequently incomplete closing and incomplete opening are found together, as also is a diseased state of more than one valve.

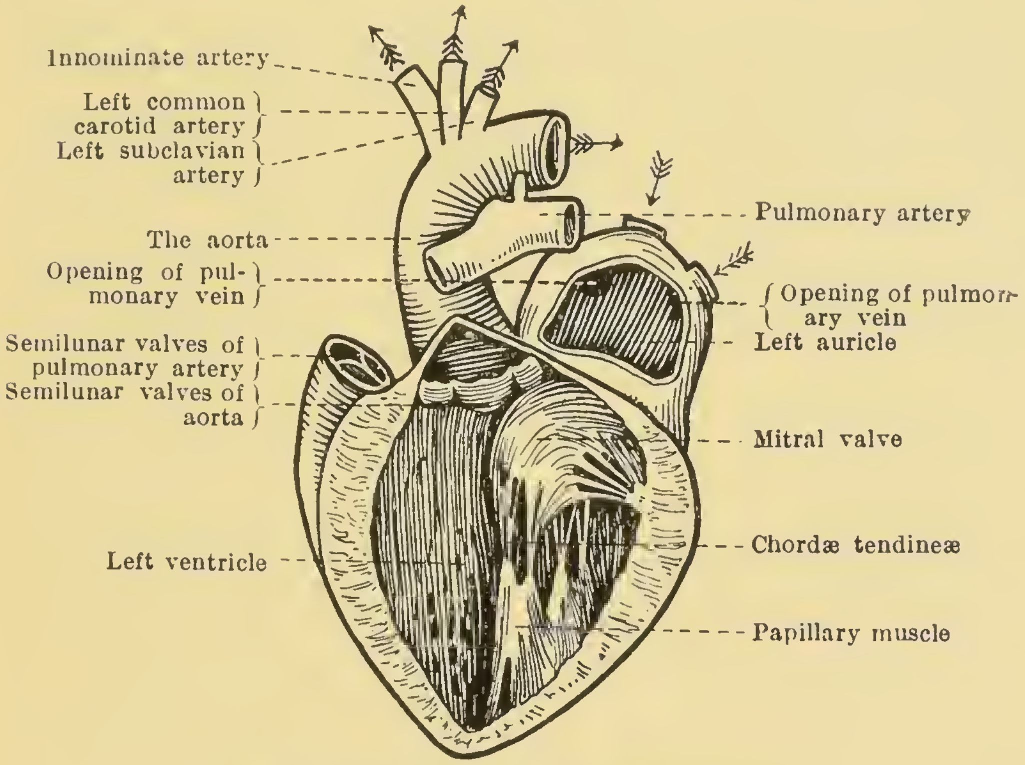
Innominate artery
Left common carotid artery
Left subclavian artery
The aorta
Opening of pulmonary vein
Semilunar valves of pulmonary artery
Semilunar valves of aorta
Left ventricle
Pulmonary artery
Opening of pulmonary vein
Left auricle
Mitral valve
Chordæ tendineæ
Papillary muscle

Fig. 16.—Left side of the heart (laid open.)
(The arrows indicate the direction in which the blood flows.)
(*From Warwick and Tunstall's "First Aid to the Injured and Sick."*)

To return to the blood-vessels, and firstly to the arteries, as the principal agents in the transmission of blood throughout the body. Those alternate upstrokes and sinkings which we feel in arteries where their pulsation can be felt, correspond to the alternate contractions and pauses of the heart, with the resulting injections of so many ounces of blood (two or more) into the aorta. Hence the movements of the pulse can be taken as true indications of the pace and force of the heart movements. The elasticity of the arterial walls, however, renders the beats of the pulse considerably less marked than those of the heart.

Each jet of blood injected into the aorta finds the aorta already full of blood, but room is made for each succeeding addition thanks to the elastic nature of the walls of that great blood-vessel, within which these jets, or waves, of blood rush at a greater pace than does the blood-current. This pace, however, gradually lessens as the blood-wave advances, till both force and pace subside in the capillaries.

It is to the advantage of the tissues that the pace at which the arterial blood passes through the capillaries should be slow, for it is by these tiny vessels the blood has to carry on its work of feeding the tissues with the oxygen it contains, and of gathering up waste products, a double work, which, owing to the perviousness of their delicate walls, the capillaries are well able to accomplish.

In the veins, the movement of the blood is not intermittent as in the arteries, but continuous, because in them the propelling force of the contractions of the heart scarcely tells at all ; hence, except in some morbid conditions of the circulation, there is no pulse in the veins. The blood is helped onwards by the pressure given by the contractions of the muscles which surround the veins, and to prevent any return of the blood, most veins, especially those of the lower limbs, are well provided with supporting pocket-shaped valves. Moreover, the intercommunication of the smaller veins ensures to blood returned from one vein an open passage into another vein.

Both arteries and veins are subject to the deteriorations that the wear and tear of years bring. In the aged, the blood-vessels become thickened and hardened, or some of the channels may be blocked, or perhaps in parts permanently dilated. Inflammation or disease may forestall these senile changes, but in either case the consequently ill-supplied and withered capillaries cease to be able to carry on their vital office. All these conditions, inasmuch as they affect the circulation unfavourably, work towards that inevitable end—the extinction of life.

SUBJECT IV continued.—Lecture 2

CONCERNING SOME DISEASES OF THE HEART IN THEIR MOST EVIDENT EFFECTS

Seeing that in the last lecture your attention was entirely directed to the circulation of the blood and the mechanism of the heart, I hope you will be able to follow what I say to you on to-day's subject, "Some diseases of the heart, in their most evident effects." It is to their most evident effects that I purpose especially to direct your attention, for as a rule it is only when a disease of the heart has become apparent, either from its disabling or life-endangering results, that the nurse is called in. At the same time, I will not disregard the probability that when occupied with such cases you would wish to have some understanding of their exciting cause and peculiar symptoms, and of wherein lies a chance of recovery. For example, you might wish to know what causes the blue colour of the poor little girl we have here, or to know the nature of the heart disease from which an old lady died last week, whom for long you had seen distressingly breathless and unable to move without pain.

You may remember how I dwelt in the last lecture on the delicate and complicated structure of the valves of the heart and their workings. The soundness of the valves is all important to a true balance of the blood-circulation, and with it to health and life. This is so fully recognized that in medical language the term "diseases of the heart" came at one time to be practically limited to those of a valvular kind—perhaps this is less the case nowadays. I think I may not improperly allow myself, in speaking on this subject, to make use of the term "diseases of the heart" as applicable to all structural heart lesions or defects, as opposed to functional troubles that affect the action of the heart.

It will be difficult for you to understand the nature of the diseased conditions of so complicated an organ as the heart, such as supervene when perhaps only one of the closely-related parts of that organ is invaded, just as it is difficult for even the best of doctors to disentangle the many cross influences that may be at work in a heart patient—influences produced maybe by other organs, the special difficulty then being to decide which is the primary factor in the sum of troubles. It will simplify the subject, I think, if we set about the study of the functions of the heart when under the disturbing influences of disease, somewhat as an architect sets about the inspection of some building, to ascertain its soundness or unsoundness, the causes of unsoundness if present, and the possibilities of restoring it. By a superficial observation of the structural character of the building and of its general aspect as affected by weather and time, he would so far be enabled to judge of its stability. But if a closer inspection disclosed certain defects, he would then proceed to seek the cause or causes. For example, if he found signs of damp, he would inquire whether it arose from a wet subsoil, or from cracked house pipes, or from an unsound roof, or whether it was merely superficial, resulting from windows left open or from lack of fires. Say the main walls bulged; in that case the question would be, was the cause a too heavy superstructure, or the sinking of foundations, or bad materials, such as poor bricks. As regards the damp, if it resulted merely from lack of proper airing, etc., this would be of far less moment than if due to any of the other causes I have mentioned; though even so, if long-continued, it might create serious damage. So heart troubles, slight in themselves, when neglected and allowed to last long may become serious. The sinister yielding of a building's main walls may fairly be said to correspond to a failing of the muscle-wall of the heart, whether such failing comes from a bad foundation—a disease-tainted or inherited poor constitution—or from the powers of the muscle having been overtaxed or overstrained. The result is the same. This comparison, however, by no means holds good in one very important point, for the well-being of the house-walls depends largely on absence of saturation, while that of the heart, on the contrary, demands complete saturation, not, it is true, with water, but with good feeding blood, for in the heart nothing tells so much as the good or the bad condition of the heart muscle.

As to the suggested leakage of water from house pipes, this, as no doubt you know, might come from their ball-taps being corroded or blocked, or from the pipes being lime-blocked throughout, with consequent perforations or ruptures made by the water in forcing its way out. Even so do disasters occur in our bodies, due either to the ball-taps—the valves—being out of working order, that is, permanently blocked or permanently gaping; or to the afferent and efferent pipes of the heart being blocked, as in old age or, prematurely, through high blood-pressure; or to some disease which has produced these conditions.

As there are accepted technical terms for all parts of a building, and for the materials used in its construction, so there are recognized names for all the parts of the heart and for the various diseases to which they are subject, and you must accustom yourselves to their meaning and use. Some I believe you have already mastered; for instance, auricles and ventricles—the names of the upper and lower chambers of the halves of the heart; also the names of their mid-valves—mitral, in the left half, so called from its resemblance to a mitre, and the tricuspid (three-cupped) of the right. Now I must ask you to master the following, if for no other reason than that it saves time to know them.

Pericardium—the covering of the heart: *Pericarditis*—inflammation of the pericardium.

Myocardium—the muscular tissue of the heart: *Myocarditis*—inflammation of the myocardium.

Endocardium—the linings of the heart. *Endocarditis*—inflammation of the endocardium.

Septum—the dividing wall between the two ventricles of the heart.

Coronary System—the blood-vessels of the heart.

As indicative of differences in heart troubles—differences as to position, character, and importance, the following terms have been adopted:—

1. *Functional* diseases, that is, disturbances or irregularities in the workings of the heart, due, not to any change in the organ itself, but to external influences, or resulting from impure or poisoned blood, or from an insufficient blood-supply.
2. *Organic* diseases.—This term is used to express the exact opposite, namely, any heart trouble not merely functional in its nature.
3. *Congenital* diseases are malformations dating from birth.

In speaking to you of organic heart diseases, I prefer to start, not with valvular lesions, but with pathological conditions of the covering, wall, and lining of the heart, since these are often the starting-points of valvular lesions, more especially when present in the lining, which lining in the chambers of the heart and in their contained valves is as much all of one piece as is the lining of the sleeve and of the body of a coat. Fraying at the armhole caused by friction or by bad fitting affects alike the lining of the sleeve and the body lining where it joins the sleeve, and so it is with the lining of the heart and of the blood-vessels at the points where they enter or leave the heart.

PERICARDITIS.

The covering of the heart, like that of the lungs (the pleura), consists of two sac-forming layers, which, like those of the pleura, secrete a lubricating lymph. The pericardium, besides being a protecting and oiling envelope, fills the part, as it were, of a canvas hammock for the heart to rock about in ; for the heart rests on no firm base, but swings, bound at one end by part of its covering to its posts, its big blood-vessels, and to the base of the lungs, while at its other extremity it is attached by a few bands to the now flat, now arched, now rising, now falling, diaphragm.

Inflammation of any organ excites over-exercise of the special work that organ has to fulfil. So in pericarditis. The two serous layers, when inflamed, will over-secrete the lymph, till, because of the distention it creates, it becomes a disturbing quantity, affecting adversely both the heart and the enveloping lungs by reason of the pressure which its increased size exerts on the heart. In some cases of pericarditis, when subsidence of the over-secreted fluid is not followed quickly enough by its withdrawal by the overtaxed lymph-ducts, that fluid may thicken and form an uneven surface addition, in place of the normal smooth surface which permits the layers to glide over each other. With roughened surfaces there comes a rough friction, which the stethoscope reveals. Additional bands of attachment, such as grow across inflamed joints, may result from inflammation, and they may perhaps stretch across between the folds of the pericardium, or so closely unite the heart with its covering as to obliterate the pericardial cavity (the line of separation). Other fibrinous attachments may develop between the pericardium and the chest walls, or the size and number of the bands which normally attach the lower end of the pericardium to the diaphragm may be much increased. When the additional adhesions are within the chest walls, a perceptible dragging on the rib (costal) centres and on the lower end of the breast-bone during systole (contraction of the heart) reveals their existence. Here you have an evident symptom of this heart ailment, whereas two other marked symptoms of pericarditis are perceptible only to a stethoscope-aided ear, namely, the friction sound already spoken of which is produced by the roughened surface of the layers, and the increased size of the central triangle (that part which, unlike the rest of the heart, is not covered by the lungs), caused by the lungs being pushed more apart than they were prior to the occurrence of pericarditis.

The presence of additional attachments and the weight of secreted fluid tax the impulse of the heart and limit its movements, and tell in consequence on their correctness and strength. In serious attacks of pericarditis, other symptoms besides those I have named are :—pain, a sense of fear, shortness of breath, a constant short cough, and a fever temperature and pulse. If along with pericarditis there be blood poisoning, the secreting fluid may turn to pus, which is what constitutes "suppurative pericarditis"—that most alarming form of this particular heart inflammation.

Pericarditis in itself is not often fatal, unless either suppurative or the sequel of some other disease (under which conditions it has been known to kill in forty-eight hours), yet in children, or when acute, with such extensive effusions as to render the heart's action weak and laboured, with a great tendency to faintness, any exertion on the part of the patient becomes dangerous. Hence the need for most careful and attentive nursing. Such patients ought not to be allowed to make any sharp or sudden movement, and should be kept in as recumbent a position as the difficulty in breathing will permit, while their strength must be well maintained.

MYOCARDITIS.

So commonly is myocarditis accompanied by inflammation of the covering or of the lining of the heart, or of both, that it is difficult at times to decide which was the part primarily involved, seeing how many of the symptoms are common to both. Suppurative myocarditis is often a primary inflammation when it is the result of a pyæmia that has produced necrosis of the long bones, or when it is the accompaniment of typhus fever, or when due to the inflammatory action of microbes on the myocardium. It also occurs owing to bad nourishment of the heart through poisoned or poor blood, or from an insufficient blood supply, whether due to anæmia or a bad working condition of the vessels which feed the heart—the coronary vessels. Be the inflammation of the muscle of the heart primary or not, chronic or acute, the results are disastrous, for they alike weaken the all-important contractile power of the said muscle. All muscular tissue possesses this power, but it is of more vital importance in the muscle of the heart than in any other part of the body, for even if the valves of the heart are in good working order, the circulation of the blood cannot be properly maintained if the heart muscle fails to contract 72 times in a minute, and to do so sufficiently powerfully to expel and drive onwards the blood contained in the heart chambers. The contracting and relaxing movements of the heart might be compared to those of a hand sponging a child, which hand slackens its grasp on the sponge to let it fill with water, and then sharply squeezes it to empty it, and goes on repeating the process.

Weakening of the heart muscle may lead to any one of the following forms of degeneration: (1) Atrophy, that is, shrinkage; (2) Fibroid degeneration—a substitution of fibrous tissue for good muscular tissue; (3) Fatty degeneration—the presence here and there throughout the muscle tissues of granular fat instead of true flesh elements, a substitution which, as in fibroid degeneration, implies loss of contractility. Both (2) and (3) involve liability to sudden death, and so insidious may be their progress, that not infrequently death overtakes the victims of these heart conditions before they have realized their precarious state, the evident and usual symptoms of pain, breathlessness, or dropsy, having been absent. In other sufferers from fatty degeneration, on the contrary, indications are plain, such as great pallor, or blueness of the flesh tints, or possibly even anginal attacks or syncopes. Patients so conditioned may be invalided, and incapable of any maintained movement without its bringing on pain, and yet live for years. In fibroid degenerations lies a further danger. The parts of the heart-walls which have become thinned out provide a condition favourable to the formation of aneurysms, obstructions that further strain the muscular powers of the heart, and which may involve fatal heart rupture.

These muscle degenerations represent what in old age might be called the normal decay of the heart, leading to the subsidence of its vital power, a result often covered by the phrase "from heart failure," so common in the obituary notices of those whose years have exceeded threescore and ten, when these words stand unqualified by such additions as "consequent on pneumonia," or "following influenza."

Besides the changes that often arise in the wall and chambers of the heart, there are two conditions, in part included in the above, known as hypertrophy and dilatation, which may work either for good or for evil. Hypertrophy most often works for good, in that it helps a heart to meet the strain caused by a wrecked state of its valves. But I will speak of these two conditions in the next lecture, when our subject will be "Valvular Diseases."

ENDOCARDITIS.

It is rarely that endocarditis is present as a primary inflammation, and still more rarely does it continue for long the sole field of inflammation within the heart. The commonest cause of endocarditis is rheumatic fever, a disease often disastrous in its results in adults, and which in children, when combined with endocarditis, generally brings a fatal or disastrous heart inflammation. When the fever is not great, nor long continued, the swelling and the small wart-like growths proper to rheumatic fever may disappear from the delicate lining of the heart. On the other hand, should the fever be acute and protracted, the valves—whose tissues as I have already told you are one with the endocardium—will share in the results, results far more destructive to the mechanism of the heart than when inflammation is limited to the endocardium.

ANGINA PECTORIS OR CARDIAC SPASMS.

Though some predisposing bad heart condition—of which a blocked state of the coronary arteries is the commonest—is generally present in persons subject to anginal attacks, angina pectoris cannot rightly be said to have a heart origin, inasmuch as these attacks occur in persons who show no signs of either diseased or degenerated hearts or blood-vessels. Indeed, the paroxysmal character of anginal attacks—their sudden advent and sudden subsidence—rather suggests some nerve affection as their cause, whether of the great nerve centres in the medulla, or of the nerve branches which act on the blood-vessels, or of the cardiac ganglia. Or perhaps an abnormally exerted nerve in some other troubled organ is reflected on to the heart. That cramp-like contractions of the blood-vessels is the cause of the excruciating pains which mark angina pectoris is made evident by the relief gained when either nitroglycerin or amyl is made use of, both drugs being powerful dilators. Further, as regards the cause of cardiac spasms, it surely might be argued that if the vitiated blood of a gouty person is the cause of neuralgia, or if uneliminated waste products lead to over-contraction of the arterioles and capillaries, with resultant high blood-tension, might not some other bad element in the blood be in some cases the cause of an anginal attack ? This explanation suggests itself as a possible one, more especially for attacks occurring in the course of the night, as is often the case, when neither cold, shock, nor distension of the stomach can be to blame as provoking agents.

In a typical case of genuine angina pectoris, the pain comes on suddenly in the chest or left arm, or sometimes in both arms. The body and arms grow cold and become covered with sweat, while the sufferer's distorted face tells not only of excruciating pain, but also of the sense of terror with which he is seized, till in the worst cases a syncope or convulsions lead up to death even in a first attack, or if not, in a second one.

Pseudo- (false) anginal attacks, or modified anginal attacks as it is perhaps better to call them, unlike those of true angina pectoris, are often frequent, occurring even several times in one day. Fits of indigestion, flatulence, distension of the stomach, exposure to cold, the act of lying down in bed, mental worry, any one of these causes may suffice to bring on an attack where there is an established predisposition, and still death eventually may not be the result of an attack, while in some persons the attacks only occur at long intervals, and they enjoy fair health and are able to get about, till an unlooked-for and unusually severe attack suddenly causes death. Others, on the contrary, can only purchase immunity from life-imperilling seizures by leading the life of an invalid in a recumbent position. It is such patients that you are likely to have to attend. My one word of warning to you if you do attend such cases is, "Never fail to have at hand the relieving, it may be life-saving, nitroglycerin tabloids, or you may live to regret it."

SUBJECT IV continued.—Lecture 3

VALVULAR DISEASES

In last week's lecture I spoke of the effects of inflammation on the endocardium, and how common it is for its bad results, namely, swellings and wart-like growths, etc., to extend to the valves. Valves so affected may stiffen, crumble, thicken, or almost grow together (buttonhole), and so no longer fit together owing to acquired narrowings and irregularities; also they may be rendered incapable of drawing well together through shrinkage of, or a breach in, their controlling chords; or, under strain, the flaps may rupture. The commonest cause of valvular imperfection is the existence on the margins of the valves, of growths which, instead of subsiding with subsiding inflammation, become the basis of fibrous or of calcareous deposits, known as "vegetations." These may either block the outflow of the blood or prevent the perfect closure of a valve and so permit return of blood into the chambers (regurgitation), or both. They present another evil, inasmuch as they may become detached—either entire or in particles—and be carried by the blood-stream till, as embolisms, they impact in channels that are too narrow to allow of their further progress. When this occurs in a brain vessel, paralysis is the result.

Before speaking further about valvular lesions, I must make sure that you understand the meaning of certain technical terms. By "regurgitation" is meant blood returned to a chamber from which it had been expelled. This can occur only when the valves of a chamber do not properly close after having opened to allow the blood to pass over them. The term "stenosis" is used to express obstruction or otherwise produced narrowing of a valvular outlet. When "double mitral lesions" are spoken of, it means that some obstacle (very probably "vegetations" on the margins of the valves, say of the mitral), has the effect not only of delaying the outflow of the blood, but also of preventing a complete closure of the valves, thus allowing "regurgitation," the result of which is that a chamber becomes overcharged with blood.

The commonest valvular lesion is mitral regurgitation, or, perhaps, mitral regurgitation combined with mitral obstruction. Next comes mitral obstruction (stenosis), after which aortic regurgitation along with mitral obstruction, and rarest of all, stenosis of the aortic valve.

Aortic lesions are in themselves the most dangerous ones, though their gravity, as is the case with any valvular lesion, mainly depends on: (1) The provoking cause; (2) The patient's age; (3) His general health; and (4) Whether endocarditis is acute or chronic. If chronic, the ugly feature of progressiveness attaches to the lesion. Further, an accompanying pulmonary or kidney disease, or unsoundness of the heart substance, make a vast difference, for many a person lives long and in fair health in spite of pronounced aortic or mitral lesions, while others, with less extensive valvular lesions, early become invalided and die by reason of the complications produced.

The tendency in aortic disease to syncope or to sudden death seems due to the aerated blood being too slowly or insufficiently expelled, so causing failure in the circulation of the blood in the great cerebral nerve centres that control the action of the heart and the respiration, thus rendering them incapable of well-maintained actions, with syncope or death as the result.

In mitral disease such dangers are not so much to be feared, but its victims are subject to many complicating symptoms, owing to that delayed venous return to the right half of the heart which is so marked a feature in mitral lesions. Hence a general stagnation of the blood—a venous stagnation—which has been known to reach so extreme a point that when a vein was opened, no blood flowed from it. Even with far less stagnation the results may be congestion of the lungs and liver, with breathlessness and pain over the heart. It is in proportion as these symptoms yield or hold that dropsy sets in about the feet or in the abdomen, for one of the exciting causes of dropsy is the extra pressure produced in slow-moving veins. With the advent of dropsy, the patient's sufferings vastly increase, for if it is considerable he may no longer be able to move about or to lie down with any comfort. Then indeed are the good offices of a nurse required. Whatever arrangement affords such a patient the most relief—be it propping the shoulders with many pillows, or spending the night as well as the day in an arm-chair, or kneeling on the bed with well-supported elbows, or plunging the hands into hot water, or hanging the legs over the bedside—recourse may be had to in private practice, the choice being left to the patient. But, alas! with limbs that cease not to swell, and with the water of dropsy continuing to rise, little ease is to be found in any conceivable position. With some such patients the skin sloughs, or clots may form in the veins, thus adding a further obstruction to an already handicapped circulation, and with the terrible possible result, in extreme cases, of gangrene of the extremities.

Tappings, digitalis, mercury, and alcohol sometimes succeed in reducing heart-induced dropsy and in allaying the worst symptoms, while hypodermic injections of strychnine can be credited with having often proved successful weapons in warding off impending death. But after oft-repeated relapses, drugs and stimulants alike fail, and the battle for life is lost.

In the early stages of aortic regurgitation, palpitations, pain, breathlessness, headaches, and giddiness prevail. In later stages, the advance of cardiac failure is shown by fainting fits, by trembling of the knees, and by dimness of sight. Finally, syncope, apoplexy, or paralysis from an embolus in the brain, brings death. This description only applies to pure aortic regurgitation, that is, aortic regurgitation not combined with mitral disease, a much commoner condition, and that from which, I believe, the little girl in Ward xxx is suffering. Her even pulse is not at all like the hard stroke and sudden collapse of the so-called "sledge-hammer" pulse, which is characteristic of aortic regurgitation, while her varying dropsical state tells of mitral trouble. On the other hand, with her bright and clear complexion, there can be none of that congestion of the liver which usually accompanies mitral disease, and gives to the skin a greenish tint—a crossing as it were of the blue colour of cyanosis with the yellow of jaundice.

In aortic regurgitation, the neck arteries may throb so visibly as to attract the notice of a near-placed casual observer, or even so strongly as to jerk the unfortunate patient's neck. Valvular lesions in the right half of the heart are much less frequent than in the left, and are rarely primary, except when they represent congenital malformations, but are rather the consequence of the strain which a bad condition of the left side puts on the valves of the right side.

"Tricuspid regurgitation"—I need hardly remind you that I now speak of the middle valve of the right half of the heart chamber—often seems to supply as it were the last page in a sad chapter of heart disasters, and one that leads up to a calamitous finale.

With "tricuspid regurgitation" goes that peculiar phenomenon "reflux pulsation" in the neck veins (the jugular), for veins, as you know, do not as a rule pulsate as do arteries. The explanation of this unusual pulsation lies in a failure on the part of the over-charged ventricles and auricles of the right side to dispose of an abnormally large quota of contained blood, and to some of that blood consequently being repulsed, either up the jugular veins *via* the vena superior, or down the vena inferior. The effect in the former case is to set the jugular veins jerking, and in the latter to produce what is known as a "pulsating liver," or at least pulsation in the hepatic veins.

HYPERTROPHY AND DILATATION.

Valvular lesions once established are irreparable damages, and would be hopeless misfortunes did not Nature come to the rescue, not to cure the lesions, for that she cannot do, but by hypertrophy to provide extra strength to combat the difficulties that valvular lesions present to the circulation of the blood. Hypertrophy aids, because it thickens, enlarges, and strengthens the heart wall and cavities. Thus power wherewith to meet the heart's increased work is gained. Dilatation, too, is an aid, because it enlarges the internal space of a chamber by thinning its lining, the thinning being brought about by the stretching pressure that an overcharge of blood exerts on it. In favourable circumstances this condition goes to provide the extra accommodation required in cases of, say, regurgitation, when a chamber has to hold, besides its ordinary inflowing quota of blood, a certain amount of regurgitated blood, or, in some cases, blood that has not been expelled. But dilatation is far from beneficial if it is merely a form of poor general contractility, for where this is the case the valves will either gape, or close too slackly or too seldom, conditions that might lead to heart failure.

Hypertrophy when needed, and dilatation when of the type first described, are happy compensatory agents, but hypertrophy, if unrequired to combat valvular difficulties or to overcome obstructions in the arteries, is an evil, because it so hyperexcites the heart as to end by overcharging it with blood, and by so doing gives rise to breathlessness, besides putting an abnormal strain on the blood-vessels. Such breathlessness comes of the blood passing too quickly through the lungs to allow of the air-vessels sufficiently acting on it to supply the needed amount of oxygen in the blood. Hypertrophy is also an evil when the increased bulk it gives goes to diminish space in a cavity, or when it thickens the septum. Hypertrophy of this type is known as "concentric or contracting hypertrophy" as opposed to compensatory hypertrophy. In some cases, where the combined hypertrophy and dilatation are very great, the increased weight and bulk thus created so largely tell on the size of the chest as to be apparent externally, and cases have been known in which the normal weight of the heart (say about 10 oz.) has been quadrupled, while parts became so thinned out as not to be thicker than tissue paper. This condition (the bovine heart) occurs in cases of aortic incompetence.

CONGENITAL MALFORMATIONS.

Of congenital malformations you have a well-marked example in the poor little girl in St. Luke's ward, whose face has that blue colour (cyanosis) characteristic of all heart malformations. Cyanosis, however, though one of the leading features of congenital malformations, is not confined to them, for it appears whenever the blood is insufficiently aerated from whatever cause. Amongst these causes are valvular lesions that delay the passage of the blood through the lungs into the heart, or lungs which are too damaged to enable them to give off much oxygen. In asphyxia, too, however caused, there is always cyanosis, because no oxygenated air is being received ; and in some delicate persons exposure to cold will cause blueness till warmth returns.

The malformation in the little girl just mentioned is, I understand, non-closure of an opening in the septum of the heart, which after birth and after breathing is established, should close. When this does not take place, the opening or passage between the halves of the heart permits red and dark (arterial and venous) blood to mix. With the exception of stenosis (constriction) of the pulmonary artery, this is the commonest malformation, and with it the length of life varies considerably according to the size of the opening in the septum, and its position. Other and rarer malformations, with which children seldom survive more than a few hours or days, are stranger ones, such as only one auricle, only one ventricle, one ventricle and two auricles, or a reversal of the positions of the aorta and the pulmonary artery. Indeed, whenever there is any decided malformation of the structures of the heart, life is seldom maintained beyond the age of eight, or of fifteen (though there have been cases of young people with congenital malformations living on till twenty, or even beyond that age), for as the body grows it becomes more and more difficult for an imperfectly-constructed heart to carry on its work of propelling the blood and regulating the circulation. Hence come breathlessness, faintness, and dropsy, till at last a hopeless stagnating condition of the blood ends suffering. If you look at this poor child, you will see that her nose and her dark-coloured lips and fingers have thickened—the latter to such an extent as to give their tips a club-like appearance. This is one of the results of stagnation of the blood, and one which more particularly affects the extremities.

FUNCTIONAL DISORDERS.

These in themselves would not supply ward cases ; but you may often come across them in patients suffering otherwise ; or you may be subject to them yourselves if anæmic, run down, hysterical, worried, or if troubled with indigestion. In some persons, functional disorders take the form of a rapid or intermittent pulse, or of palpitations of the heart, or even of fainting fits. To these symptoms if purely functional, that is, if they are due to influences external to the heart, no danger attaches; but as they are symptoms which occur also in heart disorders, an appeal to a doctor and his stethoscope ought always to be made, so as to have the question of their cause settled by the proved presence or absence of tell-tale heart murmurs, which, if present, would necessitate care and treatment very different from those given in say, fainting from an attack of indigestion. Persons subject to functional heart troubles should avoid tea, coffee, alcohol, and tobacco, as more or less provocative of these troubles, inasmuch as they may act badly on the nerves or the digestion, especially in delicate or exhausted persons.

Should it be advisable for you to renounce these things, surely to do so would not be too great an act of self-denial, considering how much your fitness for your profession—I would fain call it your vocation—depends on soundness of health and of nerves; for have not all nurses at times to meet strains on their strength such as would inevitably break down any person not in good health? Undoubtedly, too, a nurse's condition reacts on her patients. A nurse cannot possibly be at her best if giddy from biliousness, or stiffened by rheumatic ailments—the result perhaps of reckless exposure to wettings, or too long bicycle rides in holiday times—or if she be in a fretful state, or suffering from constant fits of indigestion. A great singer, apart from ceaseless care to avoid chills and damp, will, for the sake of his voice and his career, sentence himself before singing in public to hours of starvation, and is very careful as to the temperature he lives in and the kind of fluid he swallows. Just as the singer cherishes his vocal organs, should you cherish your most precious health.

SUBJECT IV continued.—LECTURE 4

DEGENERATION AND DISEASES OF THE BLOOD-VESSELS

HAVING in previous lectures spoken to you about the circulation of the blood and the structures of the heart and the lesions to which it is subject, it now remains for me to explain to you how defects in the heart act on the blood-vessels, and they on the heart. I think I may safely start on our subject, "Degeneration and diseases of the blood-vessels," without further explanation.

This subject includes far more than can possibly be compressed into two short lectures, and much that it is quite unnecessary to trouble you with, so I will confine myself to explaining what the degenerative changes to which blood-vessels are subject imply, and will try to picture to you the altered and damaged conditions they create and so prepare a field for such evils as thrombosis (clot-forming), embolisms (clots moved and lodged elsewhere), phlebitis (inflammation of veins), aneurysms (blood-tumours), etc. I will treat of these conditions in their most serious stages only—stages which involve danger to life, or which so greatly invalid the persons suffering from them as to make the attendance of a nurse necessary.

Of the different forms of degeneration of blood-vessels you probably know little as yet, or of what it may lead to, such as paralysis caused by the plugging presence of an embolus on the brain, or large life-endangering aneurysms, or the black colour of a gangrened foot consequent on the blockage of many terminal blood-vessels, if not of a main artery. I will therefore mainly devote our time to-day to this part of our subject, in the belief that by so doing you will be helped the more readily to take in what I have to tell you concerning the diseases just named, and in the hope that if you are called to assist in the nursing of persons suffering from any of these diseases, you will come to them with an intelligent understanding as to the nature of their maladies, fully aware of the risks they involve, and capable of appreciating the importance of the objects which surgeons aim at in their attempts to assist Nature on her own lines, or to stave off death.

DEGENERATIVE AND DESTRUCTIVE CHANGES IN BLOOD-VESSELS, MORE ESPECIALLY IN ARTERIES.

A more serious matter for consideration we can scarcely have, seeing that on the efficiency of the blood-vessels our physical well-being depends, as also that fair appearance which proclaims health; while their non-efficiency causes loss of strength, many troubles, and divers diseases, or even death long ere life has reached its natural limit. To the very aged, who have escaped not only accidents but also any damage to their health from climate, plague, or fever, death, the inevitable, comes through those disabling changes which the wear and tear of years brings about in the arteries, those vessels which in life know no sleep, nor even such fractional pauses as alternate in the heart between its beats. Ever expanding and contracting, now driving, now controlling the blood in its passage through them, they must inevitably wear out, just as do delicate watch-works or a constantly-driven piece of fine mechanism. Elastic in childhood, and, if no evil influence has injured them, still elastic in middle life, the arteries in well-advanced years, with exceptions as rare as coloured hair at threescore and ten, gradually become rigid and blocked, till they cease to be capable carriers of nourishment throughout the body. This means extinction of life—an extinction that may be a veritable euthanasia, or a scarcely perceptible passage out of sleep into death, or perhaps some trifling but unwonted strain loosens the white-haired octogenarian's feeble hold on life. As with the withered leaves in autumn, some part from the tree, not loosened apparently by any external force, and flutter to the ground, while with others, a passing breath of wind, or the weight of the heavy rain-drops which their crumpled shapes and roughened surfaces permit to rest longer than if they were flat and smooth, severs their shrunken and but slightly adhering stalks from the branch that gave them birth, but from which they had ceased to draw any vitalizing force.

> " The woods decay, the woods decay and fall,
> The vapours bear this burden to the ground,
> Man comes and tills the fields and lies beneath,
> And after many a summer dies the swan."

Yet another comparison—not so poetical, but one which may help you to understand the changes in blood-vessels that degeneration produces. You must have seen old-fashioned, worn-out earthenware water-pipes lying broken up, momentarily cast aside during the work of placing their successors. A glance at these broken pieces, and a comparison between them and their substitutes, will supply the whole story. At first internally shiny and smooth, the inner glaze of the old pipes may have held good for months, or even for years, and all went well; but with time, or from a constant over-pressure of water, or owing to some chemical action on the glaze, it blistered, dissolved, and fell off in places, with the result that water lodged in those places, and there worked mischief by swelling and disintegrating the now unprotected earthenware. Further, the lime of the water combined with the sand it often carried formed deposits which gradually blocked the pipes, till one day the strain of an extra amount of water passing through the pipe, strong enough to overcome the obstructing deposits, ruptured it at some awkward turn or in some poorly-supported section. To the breaking down of the inner glaze of the water-pipes and the consequent results, I think I may not unfairly liken what happens in an artery when its delicate inner coat, the intima, begins to yield through long wear and tear, or under strong blood-pressure, or from inflammation excited by some bad element which the circulating blood carried—a poisonous element which may have led to an overgrowth of cells or to ulcerations. Or perhaps calcified deposits served to roughen or wreck the intima, and to narrow the internal channel of the arteries. Such damaging changes are not, alas! confined to the intima, for similar processes of hardening and of obstruction, accompanied by sad changes in the tissue itself, may take place in the "media" (the middle coat), that bulwark of all arterial structures. Or a further disaster may occur owing to detached and wounding pieces of calcified plates being carried by the blood-current, a condition which permits the blood to lodge in between the coats of the wall of an artery, with an evil result which has no counterpart in water-pipes, and on which for the moment I will not dwell.

Indeed it does not do to overpress the comparison, and it must not be forgotten that blood-vessels are composed of living elastic tissues, and that they constitute—at least the larger ones do—an individual system of veins, arteries, capillaries, and nerves. They also are capable of working out their own deterioration, and possibly are capable of slight self-patching efforts, while most of them have at their command means for escaping from threatening ruptures, thanks to a system of intercommunication which enables vessels to give passage to their neighbour's barred-out blood. But ruptures (hæmorrhages) do occur as we know, and most often, as in overstrained earthenware pipes, at the vessel's weakest spot, or where it has the least external support. This is exemplified by the frequency with which hæmorrhages occur in the brain, as is to be seen among sufferers from Bright's disease, the explanation of which, in part at least, is that on the soft tissues of the brain the blood-vessels have a poorer support than anywhere else throughout the body.

Normally present in the aged by reason of years, arterial degeneration is not uncommon in the middle-aged, in young persons, and even in children that are born tainted by specific diseases. It may exist in so slight a degree as to be of little or no importance, or it may be significant of danger. It may be limited to one or a few vessels, damaged perhaps in the first place by some over-exertion, or it may prevail in a number of blood-vessels scattered throughout the body, as the outcome possibly of some infectious fever or disease. Not much harm may come of it even then, though this condition ought to serve as a danger notice that such lives will not safely bear over-heavy or over-rapid traffic, and consequently should suggest the advisability of limiting mental or bodily exertion, and of adopting a low and restricted diet. The seriousness of the condition depends on the number of vessels affected, and, above all, on their situation. For example, a rigid and blocked state of the part of the aorta nearest the heart, or of the coronary arteries—the direct heart-feeders—is not infrequently the cause of sudden and unlooked-for death, while a like condition in brain vessels may cause pains in the bead, or serve to lower mental power. As regards numbers, if many terminal arteries are blocked *en masse*, gangrene of, say, a foot, may be the hideous result.

Examples of obviously altered blood-vessels are the tortuous, or worm-like, temporal vessels of some aged men, or the uneven and prominent vessels on the arms of blacksmiths, shipwrights, porters, or men who habitually lift weights, which plainly witness to the constant jar and strain that such work involves, though even in hard workers such vessels may not be perceptible in the more fleshy parts of the body. If overstrained, the larger vessels at the back of the feet may be seen ; hence a habitual "scorcher," or cycle racer, sitting astride his cycle at an angle suggestive of a large ape on a branch, and pedalling hour after hour for all he is worth, may in time render them apparent, and may besides live to see harm done to other vessels also. Some hardened vessels can only be detected by the touch of the hand, and deeply-seated or internal ones not even so, whence damaging, yea, life-endangering changes may go on unsuspected till the troubles they create indicate their disabled condition.

In dealing with individual cases of degenerative changes in the blood-vessels, it is sometimes difficult to decide whether these changes are pathological or only prematurely senile ; and if pathological, whether they should or should not be regarded as the outcome, if not a part, of some acute infectious disease or fever. If only differences in character and differences in starting-points are taken into account, then as regards types of vascular degeneration, there may be said to be three more or less determining forms, forms which, however, are often confused through their passing into each other.

Number one—not necessarily the first in point of time—is the fatty gelatinous degeneration known as " atheroma " (from the Greek word for porridge), which begins in the delicate membrane of the intima with grey or pasty patches. These may resolve themselves into ulcers, and the ulcers into calcified deposits, the larger plate-shaped, the smaller ring-like ; or large overgrowths of fibrous tissue may develop. These changes thicken, harden, and roughen the intima, and proportionately narrow the internal channel of the artery. Pre-eminently a degeneration of old age, atheroma may appear little hurtful, and even be unrecognized, but it is none the less an evil, inasmuch as it predisposes to the forming of clots, or even of aneurysms, as you will see when we come to consider that subject.

The second type of degeneration, " arteriosclerosis," or as the term signifies, hardening of an artery, has its starting-point as an independent affection, not in the delicate intima but in the far stronger media. Seeing how largely the media is composed of muscular and elastic tissues, and that the strength and working powers of all arteries mainly depend on its soundness, its deterioration must necessarily be a very serious matter. Not only does arteriosclerosis harden the media and block the internal channel of an artery, but when some added inflammation leads to loss of the finer elastic tissues of the media and to their being replaced by non-contractile connective tissue, then there is produced an example of the third kind of degeneration, namely, " dilatation." The term dilatation when applied to an artery, means that it no longer contracts after expanding, but remains stretched and gaping. Dilatation from loss of contractile tissue is permanent, but it may occur along with a general want of tone throughout the body, or be consequent on a paralysing nerve failure. In those cases, given no blockage, what happens is simply that for the time being the blood slips through all too easily, as is shown by great softness of the pulse.

Where dilatation is localized it goes to establish an aneurysm, because a relaxed and impassive arterial coat will bag under pressure, and in bagging it provides a ready-made sac for the blood to accumulate in, as a blood tumour. Arteriosclerosis in some cases seems to be rather a senile development of atheroma than an independent degeneration, while contrariwise atheroma may follow on arteriosclerosis, a combination some writers on this subject are disposed to look upon not as an evil but as an effort on Nature's part to patch and shield damaged spots from the action of the passing blood. These are not the only possible degenerative and destructive combinations, for on the wreckage of the media there may follow that of the adventitia (the outermost coat), with a consequent necrosis of the vessel.

Nowadays, the term arteriosclerosis is sometimes used to cover any and all rigidity and blockages of arteries, however begun, and in comparing the respective distribution of atheroma and of arteriosclerosis, it is not unusual to state that the former is the type of degeneration most commonly found in the larger blood-vessels, and the latter in the smaller ones; but as regards both localization and number, this distinction does not always hold good, for differences in predisposing causes greatly influence resultant position and extent.

Much light has been thrown latterly on the connection between infectious diseases and degenerative changes in the blood-vessels, and on the problem why one coat rather than another, or than all three, is primarily attacked. This knowledge, which in some respects is only confirmatory, has been acquired by inoculating animals with cultures of such microbes as are known to be proper to certain diseases, and when a disease "took," then careful examinations were made to ascertain the effects produced, and on which of the three coats of the vessels. Thus it was proved that various diseases produce damaging effects on blood-vessels, and that certain diseases have a predilection for the intima and others for the media as their starting-point, but naturally in sickly human subjects these distinctions may not always hold good, and reveal the cross-influences of earlier diseases, that act as disturbing factors.

It had long been recognized that degeneration of the blood-vessels in middle and early life was often due to syphilis; but it has only recently been accepted that typhoid fever also has the power to start degenerative changes in blood-vessels such as may lead to the forming of clots and to gangrene, though rarely to the latter.

Disastrous as is the evil wrought by the agents of infection, it is not on them that the blame of starting destructive changes should most often be laid, but rather on the strain of a too great blood-pressure, which agent may also be responsible for the developments which follow on the bad changes started by an infectious disease. Damage once wrought is irreparable. That which has hardened cannot be made soft, that which has become rough cannot be made smooth, nor can that which has yielded be as if it had never yielded, any more than what had once been a smoothly-chiselled block in a sea wall can recover its smooth surface once it has suffered from having had its softer parts washed away, leaving its harder ones projecting and denuded. High tides, great storms, and the grasping lash of waves will scoop out the largest and most deeply-imbedded pebbles, and the holes and hollows thus made get filled by succeeding in-driven discolouring sea-waves. Just think how different would have been the extent and rate of change in such a block had it formed part of a wall in a sheltered garden or road, instead of an exposed sea wall. All that would have happened would have been that slowly an even coating of green fungus would have wrought a change in its colouring, while many a summer's baking sun might have reduced its softer surface parts to dust, which winds would carry far and near. Even so blood-vessels fare very differently according to what they have to encounter in the shape of usage. Long, but not for ever, will they hold good against a fair pressure of blood as it passes through them, but over-pressure and an undue strain will harden or roughen them, or perhaps they may yield in places, or become fouled by suppurations (so common in phlebitis), and hence at last be wrecked and degenerated. Still, though the harm done cannot be undone, yet in even the worst cases if fitting dietary be strictly adhered to, and exertion avoided, an otherwise inevitably fatal or sudden termination may be escaped and even increase of degeneration arrested.

I think enough has now been said to allow of my taking aneurysms and other developments of degeneration in blood-vessels as the subject of my next lecture.

SUBJECT IV continued.—Lecture 5

ANEURYSMS AND CLOTS

I last spoke to you about the best-known and most frequent maladies of the vascular system, though only of those that I might call the wider ones. To-day I will direct your attention to some more specialized or individual diseased conditions, most of which may fairly be looked upon as the developments or direct consequences of predisposing degenerative or other changes present in the coats of the vessels where they occur. Such undoubtedly are aneurysms, with an account of which I propose to begin to-day's lecture, for an aneurysm is no more likely to develop in an unimpaired and healthy artery than blisters to rise on recently applied good oil paint, unless exposed to burning heat or to some other destructive agency.

The name "aneurysm" is given to a class of blood tumours which develop within the walls of arteries, and which pulsate in common with the heart. The growth in size of an aneurysm, when growth there is, comes through a gradual accumulation of blood and of such of its constituents as it deposits while passing through the aneurysm-containing artery, retention and accumulation being provided for in the continual extension of the sac that had been produced by the bagging of one or more of the coats (perhaps the media along with the outer one) of the wall of the artery, till the fatal day of its rupture arrives.

Aneurysms vary greatly in size, from the miliary aneurysms of the brain vessels—no bigger than a pin's head—and the small ones common in tubercle-damaged lungs, which are often answerable for hæmorrhages in consumptive persons, up to an aneurysm in the trunk as large as a child's head. The largest oftenest have their seat in the upper divisions of the aorta, or in the upward-turned arteries which proceed from the aorta, while large ones occur less frequently in the abdomen. None of these can be spoken of as being common.

Aneurysms in an abdominal artery sometimes give rise to more excruciating pains than do aneurysms otherwise situated, bad as that may be in some of their stages. In an early stage pain is caused by the overstretching of the artery acting on nerves, and later, by the pressure that its increased bulk brings to bear on surrounding parts.

If you saw a limb aneurysm—say a popliteal (a ham)—under treatment, whether by direct pressure on the artery or by ligature, you would learn much as to the nature of an aneurysm, and in consequence would understand the object aimed at by the different methods of treatment used. Better still, could you see a consolidated aneurysm dissected, for you would then see how like those of an onion lie its clot-laminated layers, though very probably the aneurysm would be far from having the perfect globular form of a fine Portuguese onion ; indeed, it would not have consolidated had there been no inequalities in its shape nor projections on its inner surface, for these serve to promote coagulation. Nor would all its layers, like those of an onion, be of the same colour, for the red corpuscles which give the red colour to whatever the blood deposits as it passes through the sac of an aneurysm, may have lost their colour, and hence some of the layers would be colourless, and others not.

As to the thickness of the wall of an aneurysm, it varies with certain conditions,* and with its variations the chances of an aneurysm rupturing increase or decrease. The possibility of cure or of arrested growth rests on well-grounded consolidation, and it in its turn largely depends on the force with which the blood passes through the artery, that is, if the position of the aneurysm saves it from receiving the full force of the current, in which case deposits have a better chance of not being washed away than would be the case if it did.

Aneurysms, as I have said, develop only in arteries which have been hurt or weakened by some damaging cause, such as acute inflammation (arteritis), existing atheroma, or the toxic action of infecting agents or of some bad elements in the blood. Or the cause may be an external injury, say a blow or a wound that affects an artery internally; or, again, undue stretching or overstraining of a limb by its too great or too long-continued exertion. Aneurysms are often due to the strain involved in such strenuous occupations as those of the soldier, collier, and smith, more especially if the position in which the work is carried on is a constraining one, or if with each blow the breath has to be held, the effect of which would be an intermittent increase in blood-pressure, a result more likely to prove detrimental to the arterial walls than even a constant very high blood-pressure. The two last-named predisposing causes seem to account for aneurysms occurring more often in the aorta and in the popliteal artery (ham) than in other arteries.

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* The wall of an aneurysm is formed partly from within and partly from without, the relative extent of the two processes depending on the strength of the blood-current. When this is strong there will be no clot and the wall will distend, and should the formation of fibre externally not be sufficiently rapid, it will rupture. When the blood-current is slow or absent, clots are deposited which will be invaded from the wall, and be absorbed and replaced by fibrous tissues which will become part of the wall. If this occurs throughout the whole of the aneurysm, this will in time be absorbed, a little more connective tissue being all that is left.

See C. J. Ballance's treatise on "The Ligation in Continuity of the Great Arteries," *Plate IX*, page 308.

The aorta, even when not subjected to special strain, must suffer more than any other artery from the wear and tear of years, seeing that each heart-expelled jet of blood makes an enforcing demand on its expansive powers, added to which is that rebound of the blood that takes place each time the aortic valves close, a rebound which a soft pulse reveals in the distinctness with which the dicrotic or secondary rise can be felt. It is therefore no wonder that arteriosclerosis or atheroma starts generally in the aorta.

Should an aneurysm become so filled in with layers of clot that no space is left for blood to flow round, and if its mouth is completely blocked by clot, that aneurysm for the time is cured, but the cure would be more likely to be permanent if the adjacent parts of the artery concerned were also blocked. An aneurysm so thoroughly cured would eventually turn into a mere fibrous bag. Spontaneous cures do occur. They have been reckoned at one in a hundred on an average, but even so, and putting cures by treatment at a considerably higher average, aneurysms must still be feared as only too likely to prove fatal, and certainly to entail great suffering.

There are three well-recognized types of aneurysms.

First, the *fusiform*, which is a general dilatation of the whole circle of an artery in some degenerate or diseased part of that vessel.

Second, the *saccular*. This aneurysm is confined to one side of the channel of an artery, and is caused by the weakened and dilated coats of the artery being pressed downward and made to bag by the force of the blood-current, which quickly finds in such baggy coats a ready-made pocket as it were. It is more often the outer coat that forms such a sac, the media having been destroyed by disease in these cases.

The third, and rarest, is the *dissecting* aneurysm, so named because when the coats of an artery have been cut by a loosened calcareous fragment, or when a slit has spontaneously developed, an aneurysm of this class will go on dissecting coat from coat.

Besides these three kinds there is another type, for which "consecutive" has been thought a suitable name,* seeing that they develop consequent on the diffusion of blood into the surrounding and supporting tissues of the artery from some spot in its wall where not only all the coats but also a sheath has ruptured, though not to such an extent as to entail a serious or fatal hæmorrhage. Gradually parts of the sheath and fibres of the surrounding tissues mat together, which ends in forming a sac that communicates with the interior of the artery.

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* T. Holmes' article on *Aneurysms* in Quain's "Dictionary of Medicine," page 46, one vol. edition.

The enlargement of a true saccular aneurysm may be slow, but the size eventually attained may be very great. If so, this space-occupying bulk will give rise, as I have said, to the worst forms of pain, and to much damage from the pressure it exerts. The seriousness of the damage will depend on where the aneurysm is, for a large aneurysm shows amazing power in forcing its way beyond the point of origin, unbaffled by bones or aught else. Such an aneurysm has been known to work through the ribs till it lay externally on the chest ; while another, lodged in the descending aorta, may erode the spinal vertebræ down to the spinal cord, a disaster possible with aneurysms alike

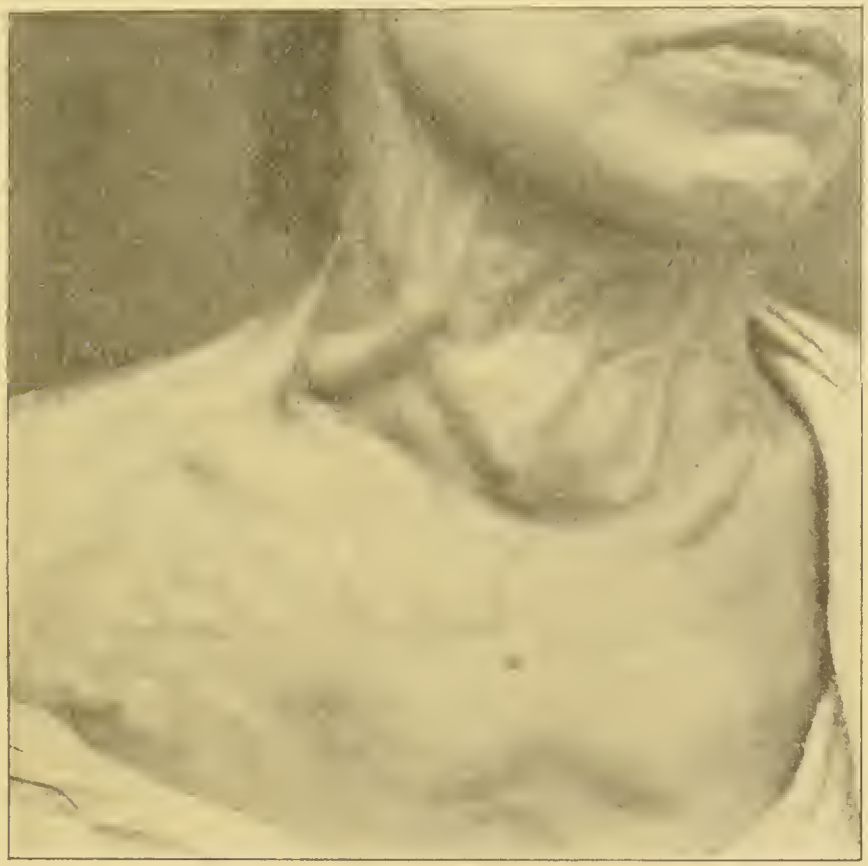


Fig. 17.—Obstruction to the superior vena cava by an aortic aneurysm ; collateral circulation through the distended superficial veins of the neck and thorax.

(*From " Index of Differential Diagnosis of Main Symptoms." J. Wright & Sons Ltd.*)

in parts of the aorta above the diaphragm and in parts below it. The latter constitute "abdominal aneurysms."

With most aneurysms there comes a day when, having penetrated into a cavity or on to some part composed of but slightly-resisting tissues, they rupture. Should the rupture take place on some organ, that organ will be flooded by an uncontrollable, fatal hæmorrhage; but in a less vital part, and if more closely surrounded, not only may death not follow at once, but it may be considerably delayed. This much-dreaded hæmorrhage is not, however, the sole possible or likely cause of death from aneurysms, for the probability of a fatal termination depends largely on the situation of an aneurysm, and on whether its increased size must fatally affect some organ or important structure (*Fig.* 17). For example, with an aneurysm on the arch of the aorta, the chance of important neighbouring structures not being affected is very small. Your anatomy lessons will suggest which those structures are, or failing that, a glance at your roller-chart will show you them. A not unlikely early symptom with an aneurysm so placed is a distressing difficulty in breathing, owing to pressure on the trachea, and given that the aneurysm did not rupture into the trachea and no other fatal symptoms developed, then death by suffocation would result. If pressure is great from an aneurysm on a main vein, a local dropsy might develop in consequence of a delayed return of venous blood to the heart. If the pressure is on the all-important coronary arteries, heart failure must ensue sooner or later, preceded perhaps by the anguish of anginal attacks. But still more disastrous as regards the amount of suffering, is an aneurysm in the descending section of the aorta, when its pressure extends to the vertebræ of the spine, which it gradually erodes, resulting probably in either paralysis or excruciating neuralgia.

Many have been the devices for promoting the consolidation by which Nature unassisted effects her cures. One of these has been the insertion of pieces of wire, in the hope they might act like foreign bodies and attract deposits. But the most common treatment is complete rest for many months—so complete that the patient is scarcely allowed to move—combined with a diet almost as low as the practically starvation diet of Varsalva, an Italian physician. A large amount of iodide of potassium will probably be added, on account of its lowering action. The primary object of this treatment is to ward off rupture of a thin-walled aneurysm from exertion or a quickened pulse; and in the second place, by lowering the blood-pressure and slowing the circulation, to promote the laying down of layers of clot, since if the blood can be made to pass less rapidly and forcibly than it normally does, it will probably not only deposit more material, but may also allow them to remain undisturbed within the sac of the aneurysm, there to coagulate.

Consolidation once gained, and union between the wall of the aneurysm and edges of the clot brought about by the invading connective-tissue-producing cells, any increase in the size of the aneurysm becomes impossible, since no blood can reach it. The distensible sac has become simply an outer covering. This life-saving consolidation is more likely to take place in a saccular than a fusiform aneurysm, since the former occupies only one side of the channel of the artery, and therefore the blood in passing strikes less directly and less forcibly, perhaps even less regularly, on it than on the latter, hence in it fibrous and other matter brought by the blood has more chance of remaining undisturbed than in aneurysms otherwise placed.

Should the object of treatment be not merely to delay the passage of the blood but to prevent any blood passing through the part of the artery which contains the aneurysm, direct and protracted compression is made use of under an anæsthetic, either by manual pressure or by special instruments; in the former case this can only be kept up by relays of nurses, for no one person would have sufficient physical strength; or, if the position of the aneurysm and the condition of the artery make such a proceeding advisable, the artery may be ligatured (tied) on its proximal side (the side next the heart). When all goes well with this operation, in a few days the artery becomes completely blocked, not only below the point of ligation but for a couple or more inches above it—in some arteries much farther—hence no blood can enter either the artery or the aneurysm.

To explain fully all this, and how an artery so treated undergoes further changes, would take too long just now; also I am afraid you are not yet sufficiently acquainted with the nature of the minute forms which compose our tissues, to understand this subject. It is the marvellous reproducing powers of these forms, and their invading and battling ways, that constitute so striking a feature in the processes that bring about the blocking of a ligatured artery, and later, either its conversion into a fibrous cord, or its restoration to its former office—that of an artery carrying blood throughout its whole length—for sometimes this does take place.

For an aortic or any trunk-placed aneurysm, not much is done surgically, and still fewer patients would submit to having one of the great neck arteries ligatured, or say, a subclavian, were it not for their sufferings and the knowledge that death anyhow is inevitable; nor would surgeons be willing to undertake operations which involve such great risks and offer so few chances of success. Far more hopeful is the outlook in aneurysms about the limbs, as is shown by the high average of successful operations on femoral and popliteal arteries. Still, even with limb arteries there are possible causes of failure, against which surgeons and patients would do well to pray "Good Lord, deliver us," so serious are their effects. The collateral arteries may prove incapable of efficiently replacing the barred artery, and gangrene may result; or there may be suppuration, possibly from some bad condition of the aneurysm; or the ligature—catgut or otherwise—may work down too soon, or slip, or be too rapidly absorbed by the busy tissue-cells, so that pulsation in the ligatured artery returns.

Attempts at curing aneurysms are now being made on different lines, and hopes are entertained of ultimate success. What is aimed at is an increased coagulability of the blood, gained artificially by the administration of chloride of calcium. The effects of this drug in man and animals go to prove that an increased percentage of calcium in the blood can be arrived at. Other facts, however, have still to be ascertained, namely: whether or not the increase thus obtained contains a sufficient proportion of the requisite ions of calcium; the length of time for which the increase will hold good; and the greatest amount the blood will accept, for it is on a satisfactory solution of these points that the success of this treatment largely depends. Considering how rickety children whose bones are too soft can have this defect lessened by the use of lime-water, and how persons who recklessly drink water highly charged with lime risk finding some day that not only have their urinary passages become obstructed, but that they are far from having benefited as rickety children do, it does not seem unreasonable to hope that in time science may enable us to accumulate lime in aneurysms where its presence is so desirable.

THROMBOSIS, EMBOLISMS, AND PHLEBITIS.

While arteries, with rare exceptions, are the only blood-vessels subject to aneurysms, thrombosis on the other hand is common to both veins and arteries, indeed it more often occurs in veins than in arteries. Thrombosis means clots which form within a blood-vessel, and which remain where formed. Embolus is the name applied to a clot, or portion of a clot, which, transported by the blood-current, impacts where the narrowness of the channel arrests its progress. Emboli may be of all sorts. The commonest are those derived from thrombi, either whole or broken up, or ones consisting of calcareous particles that come from diseased heart-valves, while others are merely blood corpuscles or pus massed together, or even things externally introduced (such as particles of cloth in cases of gun-shot wounds), and carried by the blood-stream. Impacted clots are hardly to be looked for throughout the veins, seeing that the size of a vein channel increases as it nears the heart, toward which its blood-current pours, whereas the diminished size of an artery channel the farther it is from the heart tends to arrest the onward progress of moving clots. But it may happen that a vein-carried clot ultimately acts in the heart as an embolus, causing death by obstructing the passage of the blood through the pulmonary artery and hence inducing asphyxia. Possibly, too, though rarely, a clot reverts downwards within a distended vein in the lower extremities, consequent on the valves of such veins having become disproportionately small owing to the increased size of the vein channel, and therefore no longer fitted to act as supporting props to the ascending blood in its struggle against the unfailing force of gravity, a force which goes to lessen that of the heart-given impetus. In the healthy this is partly counterbalanced by the upward pressure which muscular contractions bring to bear on the walls of leg veins. Non-efficiency in valves may result from some defect in the valves themselves, as well as from an enlargement of the veins and of their channels causing the valves to fit so badly that they become little better than ill-assorted sliding-doors.

Under ordinary conditions clots do not form within warm living bodies, but when they do, coagulation apparently proceeds as in shed blood; namely, by the evolving throughout the blood of microscopic threads of fibrin, which form very fine networks in which the blood corpuscles get entangled. Then follows separation of the fluid part of the blood from its solids, along with any solids the blood may hold. The appearance, however, of some of these vein-plugging masses suggests that they are due rather to undue-adhesiveness in the corpuscles than to any true coagulation. Be this as it may, what interests us most is to know the causes or conditions which lead to the formation of thrombi. The following are some of the causes usually thought to be conducive to clot-forming: (1) The presence within a blood-vessel of a foreign body; (2) Any roughness or projections in the inner lining of blood-vessels, such as exist in atheromatous vessels; (3) Delayed passage of the blood, a condition most likely to occur in terminal vessels; (4) External injuries that tell internally on the veins; (5) Operations; (6) Childbirth; (7) Typhoid fever, in which the forming of clots is to be explained partly by the power that fever is now known to possess of damaging blood-vessels, and partly by the protracted milk diet it entails on its victims. It was through this knowledge of these coagulation-provoking causes that the various treatments of which I have spoken came to be adopted, all attempts, in fact, to supersede one evil by creating a lesser one.

A clot may be either partially adherent, that is, adherent on one side only—the clot-exciting side—or adherent all round. With the former a certain amount of unblocked space remains; with the latter most probably none. An all-round adherent clot grows rapidly, until after repeated shrinkages and repeated additions it completely blocks the vessel. Still, neither with obstructing clots nor with emboli does harm necessarily follow, provided they do not interfere with the function of some part, and that there are sufficient collateral intercommunicating vessels to prevent any serious interruption of the local circulation, and above all, provided the impacting embolus does not carry septic matter, the probable result of which would be abscesses, and that it does not impact in a brain-vessel, for then paralysis would follow. Paralysis often arises from loosened vegetations—that grow after rheumatic fevers—being carried to the brain.

In phlebitis, clots are so often present, constituting more than half the trouble, that people are apt to look upon the term "phlebitis" as synonymous with a clot in a vein, while strictly speaking it only implies an inflamed vein or system of veins, with or without a clot. Complications of simple inflammation of a vein (simple and adhesive phlebitis) may be due to an injury affecting the vein internally, or to increased inflammation from its surroundings, or—the most dangerous form—to the infecting pus of an open abscess, or septic matter brought by an embolus. A constant recurrence of phlebitis is now looked upon as the outcome of a gouty habit or of some other unhealthy condition. This supposition no one who has seen under the microscope a drop of blood taken from a gouty patient will dispute. A drop of what is well called "gluey blood" immediately transferred to a microscope slide, and seen while the slide is not yet level nor the microscope steady, will show the corpuscles separating from their coin-like rolls, not singly but in triplets, and sliding almost imperceptibly downwards. A drop of blood taken from a somewhat anæmic person, and treated in the same way, will show unlike the first drop. In drop No. 2, the rolls look less heavy, the corpuscles separate singly, and seem to dance madly down the incline, while fibrous threads are scarcely perceptible. Surely for such lively blood much calcium and a greatly-delayed circulation would be required before coagulation could take place.

In phlebitis with a clot, whether septic or aseptic, rest for a considerable time is essential, in order to reduce inflammation and to ward off the risk of the clot passing to the heart, of which there is always a chance till it has become fully adhesive; or, if the clot is soft, till it is sufficiently channeled to provide space for the blood to pass through, and even then the limb should not be used till collateral blood-vessels have enlarged enough to replace the clot-impeded vein. Still, let a clot seem ever so firmly fixed, its death-dealing power is never lost, for after years, and when least feared, it may loosen and reach the heart. Then after about twenty minutes' struggle, which nothing can relieve, the patient dies.

In gouty patients it is quite common to find more than one simple phlebitis, either close together in one leg, or in both legs, or several on both arms and legs, but this multiplication has nothing in common with the wholesale spreading abscesses that come of infecting microbes, any more than have bruises on both sides of a person who, in tumbling, rolled downstairs.

PHLEGMASIA ALBA DOLENS.

This malady is probably known to you only as "the white, or marble, leg," a name which the appearance of legs so affected well justifies, with their hard and marble-like whiteness, very different from the sodden dark-red colour of clot-obstructed superficial veins. The difference between phlebitis and phlegmasia alba dolens is that in the latter the lymphatics as well as the veins are involved. This explains the considerable swelling of the legs typical of this malady, which in delicate lying-in women is a trying and tedious one. I will not take up our time by describing the treatment required, for I still have to speak of one more disease to which our blood-vessels are subject, one with which, I fear, you as nurses are only too likely to become acquainted owing to the amount of standing your profession involves—I mean varicose veins.

VARICOSE VEINS.

Though very trying at the best, varicose veins are only a serious or incapacitating evil under certain developments, say, when they ulcerate. The cause of varicose veins may be hereditary, or slackness in the walls may so increase under various relaxing or straining conditions that the vein becomes hopelessly stretched and lengthened, and so is unable to overcome the influence of gravity, which of course tells most when a person stands. A further outcome of this enlargement is, the resulting ill-fitting of valves which no longer act as supporting props to the ascending blood. (*Fig.* 18.) Much standing; the pressure of upper weight, as in pregnant women; relaxing conditions, such as the moist atmosphere of laundries, all tend to produce and increase dilatation and to slow the pace of the blood-current; consequently the removal of the blood is retarded. The surrounding tissues are thus liable to become dropsical, and should such a vein receive a blow, the probable and serious sequel might be a most troublesome ulcer. Varicose ulcers are very difficult to cure, because the coats of a vein's wall afford little opportunity for granulation or for the production of other repairing tissues. Varicose veins inflame readily, and clots are apt to form in them, and inflammation from whatever cause necessitates complete rest and many hours of hot fomentations. Once the inflammation is quite reduced and the patient begins to move about, the wearing of a suitable bandage is advisable, applied daily before the feet are put to the ground, and taken off on lying down. But complete immunity from pain and from the periodical rest which well-established varicose veins demand, can only be secured by multiple excisions throughout the diseased vein. This operation in a healthy subject, and with proper antiseptic precautions, is little likely to cause trouble, but relief in this way should not be sought except upon good advice, and then the operation should only be performed by an experienced surgeon.

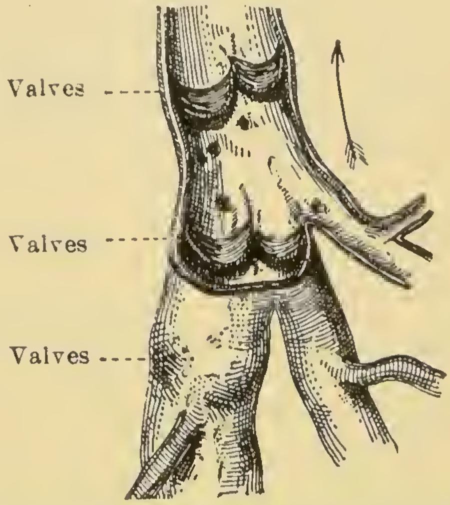


Fig. 18 —Vein with a portion cut longitudinally, showing the attachment of the veins. (The arrow indicates the direction in which the blood flows.)

(*From Warwick and Tunstall's "First Aid to the Injured and Sick."*)

SUBJECT V

THE RESPIRATORY ORGANS

LECTURE I

CONCERNING SYMPTOMS WHICH INDICATE DAMAGED CONDITIONS OF THE RESPIRATORY ORGANS

My object in speaking to you, as I propose to do to-day, about "symptoms which indicate damaged conditions of the respiratory organs," is to help you to understand what the sadly distressing symptoms which in bad chest and throat cases you are fated to see represent; but please do not for a moment suppose that I do this with the idea that you would ever be able, or would ever be called upon, to diagnose such cases. That must always be out of the question for nurses, for they have no dissecting or post-mortem experience, nor, with rare exceptions, have they had practice in the use of that great revealer, the stethoscope. I purpose setting before you how various symptoms may indicate the parts affected, and serve to mark the grave importance of their damaged conditions. Further, when dwelling on the extreme gravity of seriously damaged pulmonary tissues, I shall seek to impress upon you that however desperate a poor consumptive's case may appear, you must none the less persevere in using every care and all helpful alleviations. And you may well persevere hopefully, seeing how marvellously at times Nature comes to the rescue; maybe through a compensating strengthening of parts not as yet impaired, or perhaps, when vitality has been reduced by repeated hæmorrhages to the lowest point compatible with life, just then the offending pulmonary blood-vessel closes, and life is saved for at least the time being.

Convinced as I am how difficult, if not well-nigh impossible, it is for persons devoid of a fair knowledge of the office, structure, and mechanism of our respiratory organs to realize the disabling effects of disease, accidents, and insanitary conditions of life upon them, I feel bound to devote a considerable part of our two days' study of this subject to recalling to your memories what may have passed from them, or may never have been well grasped. At the same time I look to the consideration of the manifold destructive results produced by different types of variously located diseases, to help you to a clearer conception of the normal condition and of the constant actions of our respiratory organs—conditions and actions which secure to us easy and steady respiration, and with it health and life. For does it not sometimes happen in the inanimate world that more is learnt as to the construction of objects and the causes of their preservation or their breakdown, when they are seen damaged than when intact? Take as examples a broken arch, and the withered branch of a plant, with its tell-tale colour-changed leaves, changed long before their time. The gap in the arch discloses that unsuitable and sadly defective materials had been used; it shows, too, how poor, so to speak, was its constitution; or it might disclose that too heavy a strain had been put on it. From examination of the withered branch it would be easy to ascertain whether or not it had been so far severed from the parent stem that no sap could reach it, or whether some parasite had poisoned or sucked its life, or whether its decay was primarily due to its being overshadowed and deprived of sunlight, so that thanks to the sickliness thus engendered, a mouldy fungus had had its innings. Even so a nurse, provided she brings knowledge and intelligent observation to bear, may easily learn far more through noting the character of a patient's chest symptoms than from text-books. She may learn much concerning the life-maintaining powers and properties of the respiratory organs, and what is essential to their perfect working, when she is a witness of their inadequate or their laboured working, or of their complete breakdown. If a nurse can interpret aright what she sees, forcible indeed are the object lessons she receives from patients with such marked symptoms as hurried and difficult breathing, with blueness of the face; or with a rapid or panting breathing, along with pain in the side; or a red face, or sees blood pouring from the nose and mouth in some luckless consumptive patient.

It is of these and of other very significant symptoms that I shall speak when I draw your attention to the over-abundance and stagnation of the blood in congestion of the lungs, and to that consolidation of the all-important lung tissues which always, to a greater or less degree, takes place in pneumonia; or to the undermining work of the tubercle bacillus, a work that sooner or later, if not checked, results in lung cavities, obliterated air-vessels, and corroded and rupturing blood-vessels. The blood can never be duly oxygenated, or the nerve centres rightly vitalized, if some defect in the lungs in any way prevents its rapid and thorough circulation throughout them. It is obvious that a consolidated lung can never act as do elastic, air-receiving, and air-expelling ones, while once the fatal tubercle bacilli are fairly established, they will work as unrelentlessly as do sappers and miners in the trenches around some fortress they seek to destroy. With its reservoirs tapped and its cell walls collapsed, overwhelmed life surrenders.

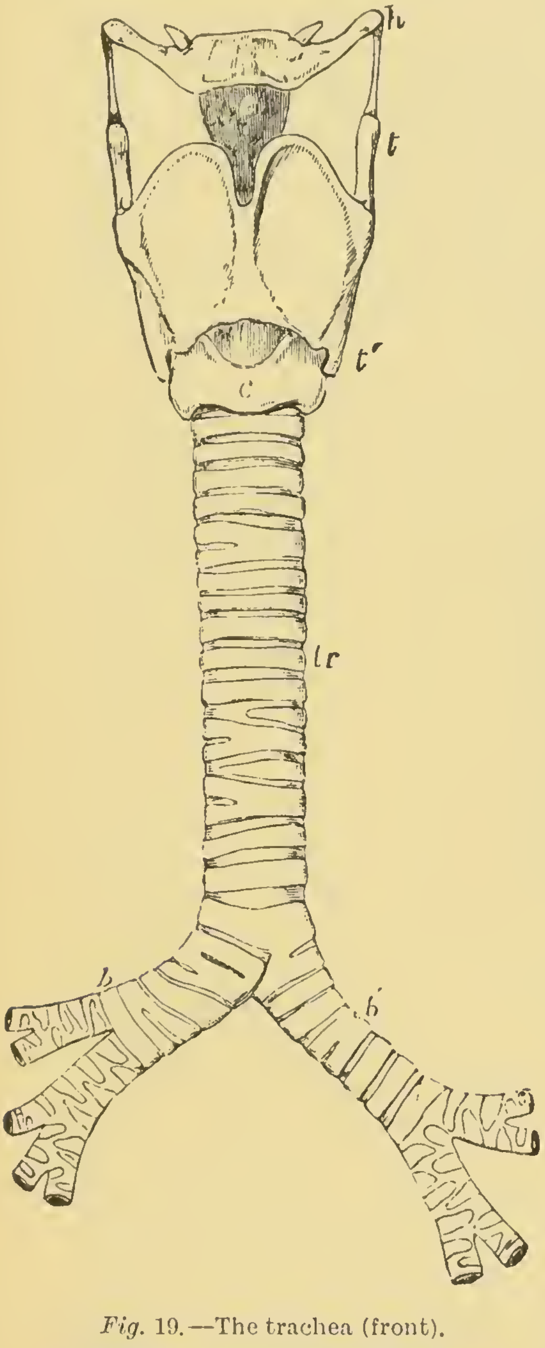


Fig. 19.—The trachea (front).
h, Hyoid bone; *tt′*, thyroid cartilage; *c*, cricoid; *e*, epiglottis; *tr*, trachea; *bb′*, bronchi.

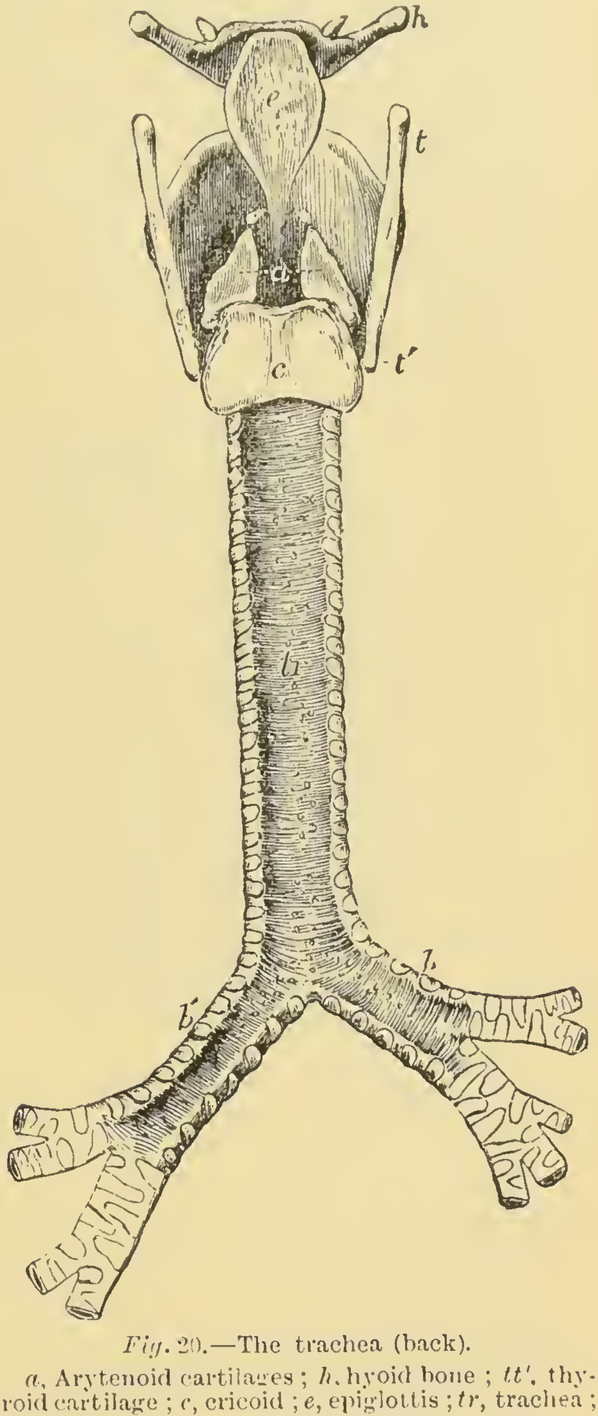


Fig. 20.—The trachea (back).
a, Arytenoid cartilages; *h*, hyoid bone; *tt′*, thyroid cartilage; *c*, cricoid; *e*, epiglottis; *tr*, trachea; *bb′*, bronchi.

(*From "Human Physiology," by W. Furneaux.*)

THE WINDPIPE: THE POSITION, FORM, AND MAIN FEATURES OF THE LARYNX AND TRACHEA.

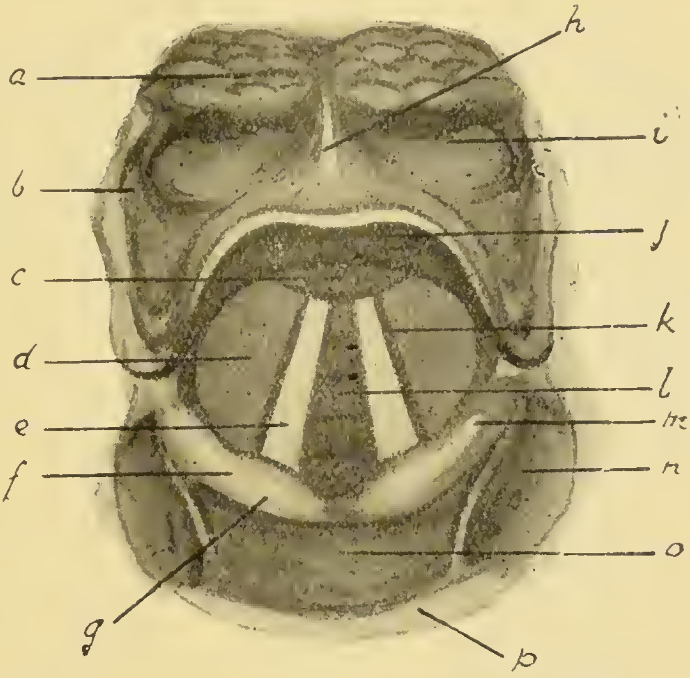
Your charts furnish excellent representations of the internal and external aspects of what, in common parlance, is appropriately called the windpipe, showing as they do its peculiarly shaped upper portion, the larynx, which, as you see, is made up of a strong framework of plate-like pieces of cartilage, while below is its considerably narrower and longer portion, the trachea (*Figs.* 19, 20). The trachea, at the front and sides, is circular, a form which, as well as its strength, it owes to some sixteen to eighteen cartilaginous C-shaped rings embedded throughout it. At the back it is flat, and as such rests against the œsophagus (the alimentary tube), at least to a certain point, after which it lies more towards or against the spine. Its walls are without any solid supports, they being mainly made up of the muscular bands which connect the tips of the C-shaped rings and retain them in their places.

In the pharynx—the uppermost part of the throat—which lies behind the nose and mouth, the windpipe and the œsophagus share a vestibule, or entrance-hall, into which enter both air (to pass into the larynx) and food (to pass into the œsophagus); but the gateway of the larynx is most effectually guarded against the intrusion of aught but air, by a cartilaginous structure—the epiglottis—which is attached by its stalk to the front margin of the larynx. Free in its broader upper edge, it stands upright for the most part so as to give a clear outlet to the air, but on the approach of solid or liquid matter, it falls downwards and so constitutes an excluding door.

Apart from the protecting epiglottis, the trachea, from its form, facilitates the rapid passage of air through it into the bronchi and lungs, for owing to its middle part being wider than the lower and upper parts, space is given for the air to turn in, and so to increase its velocity. This is a most necessary provision, for the normal number of respirations in an adult per minute is from fourteen to sixteen, while with the shallow respirations of chest patients, who are incapable of drawing a full breath, this number may be doubled, even quadrupled. Were it not possible for so many respirations to pass per minute, the blood of such patients would be poorly oxygenated, and cases of partially obstructed or of partially disabled lungs would more often prove fatal. I might draw a comparison between this and a small child called upon to keep up with a long-limbed companion. Perforce that child doubles the rate of its short steps. Both efforts, that of the child and that of the quick-breathing invalid, are performances entailing fatigue, but they attain the desired result.

Within the larynx (*Fig.* 21) lie the two true and the two false vocal cords, suspended from the curved edges of the arytenoid cartilages across on to the thyroid cartilage. Between them is a small slit, the glottis, which during silent breathing is fairly open, but which in speaking and singing becomes more or less narrowed. It is on the length of the vocal cords, and on the amount of their tension, that the pitch of a voice depends. In women and boys the vocal cords are shorter than in men, hence the usual difference in their voices. Anything that affects these parts, at once produces a change in the sound of the voice, from mere hoarseness to well-nigh total extinction, while in children, laryngitis is apt to produce spasms of the vocal cords and of the glottis, with resulting difficulty of breathing.

Outside the windpipe, at the junction of the larynx and the trachea, are the two halves of the thyroid gland—one to the right, the other to the left—with their connecting-band, or isthmus. It is this gland, when much enlarged, that produces that disfiguring swelling of the neck known to you as a goitre.



a Base of tongue and lingual tonsil
b Lateral glosso - epiglottidean ligament
c Cushion of epiglottis
d False cord
e True vocal cord
f Ary-epiglottic fold
g Swelling caused by arytenoid cartilage
h Central glosso - epiglottidean ligament
i Vallecula
j Epiglottis
k Ventricle of larynx (*syn.* sinus of Morgagni)
l Trachea
m Swelling due to cartilage of Wrisberg
n Pyriform fossa
o Posterior aspect of cricoid cartilage
p Beginning of œsophagus

Fig. 21.—Larynx as seen in the laryngoscopic mirror.

(*From "Diseases of the Throat, Nose and Ear," by W. G. Porter, F.R.C.S.*)

When both lateral lobes of the thyroid gland grow large, the pressure that comes of their size, which is further increased by the pressure which the neck muscles exert on the lobes themselves, may to a greater or less extent force the inner right and left sides of the trachea towards each other and so locally narrow its lumen.

The windpipe at its commencement is but thinly covered, in fact with little more than the skin, as you can feel if you apply your fingers to the top of your throat, but as the trachea descends, so marked is its inclination backwards towards the spine, that at the level of the breast bone, where it divides into the two main bronchi, or bronchial tubes, it lies embedded to a depth of one and a half to two inches. The trachea is crossed in front by the arch of the aorta, while at its sides run those great blood-vessels, the carotid and the innominate, and in close proximity lies the vagus nerve. To these points in the anatomy and position of the windpipe—its construction and geography, so to speak—I purposely draw your attention, because they all have a grave importance when disease or accident threatens suffocation through some obstructive closing of this our great main air-pipe, on the efficient working of which and of all its branches, and of that of the air-cells, the lungs depend for the carrying out of their office. The work of a surgeon in the very common operation of removal of a string of tuberculous glands in the neck from amongst these more important organs is a very delicate one.

ASPHYXIA.

Apart from suffocation due to some inadvertence in swallowing, which may prove fatal in a few minutes, blockage of the windpipe—productive of great difficulty in breathing, or eventually leading to asphyxia—may arise from various causes, among which are: the presence of growths or tumours in the windpipe or the œsophagus, which by reason of their size obstructingly press on to it; the croupous web, or false membrane, of diphtheria; and the heavy œdematous (dropsical) swellings of septic laryngitis. Any one of these, in its fullest development, may prove fatal if relief is not feasible or is not given in time, by tracheotomy, an operation which means making an incision in the trachea, into which an air-tube is inserted. Inoperable and hopeless are the cases when an ever-increasing aneurysm in the arch of the aorta, owing to its position, strongly compresses the trachea, for with such an aneurysm death will at last result—just as by some murderously strangling hand—unless rupture of the aneurysm and consequent fatal hæmorrhage do not forestall suffocation. Mercifully, such aneurysms are not common.

Where tracheotomy has been performed, great care and attention are required, and the attending nurse must see that the inner tube does not become blocked, that it is efficiently cleansed, and that the inserted tube is always in place. In diphtheria, a nurse has in addition to accurately observe the directions given her for her own protection against infection, and to be careful to avoid all needless risk in the handling of her patient. Every needful loving care can be given to a child suffering from diphtheria with safety, or at least with comparative safety, short of kissing the child, an act which has proved fatal to many a distracted mother.

In the laryngitis of consumption or of syphilis, with their destructive ulcers, the epiglottis sometimes becomes so damaged that it does not descend aright, and hence fails to afford perfect protection to the larynx. It no longer, as in health, resembles a well-hinged well-adjusted latch cover which when drawn down accurately covers its corresponding keyhole, but is more like some cover which either cannot be moved at all, or only partly covers the keyhole. Or the impaired epiglottis may no longer be capable of rising well, or may be turned inwards, which changes tend to diminish the size of the air-passage.

Tuberculous laryngitis is rarely a primary affection, but is not uncommon in consumption, especially its latest stage, when in all probability it results from infection from lung expectorations. As an additional symptom it so sadly increases the sufferings of the consumptive that it sometimes causes all movements of the throat to be so painful that before swallowing food the throat has to be painted with cocaine.

The Lungs and the Bronchi.

The trachea, at its lowest point, divides, as you see, into the main right and left bronchi, which with their numerous and numerously subdivided and extended branches enter and permeate the lungs, each carrying its quota of renewing or of exhausted air.

In size, the earliest given-off branches are far from small, and in character closely resemble the trachea, in that they are provided with similar strength- and shape-maintaining hoops of cartilage, and, like it, possess internally a basement membrane, a layer of ciliated cells—that is, cells with vibrating hair-like appendages—and a layer of mucous membrane containing mucous glands which open into their channels. It is on these last-named parts of the bronchial tubes that the inflammation of bronchitis tells, while in healthy patients it is the active secreting of the bronchial mucous membrane that does so much to bring about relief and recovery. The ciliary cells are at all times our excellent servants, working as they do like so many good housemaids to keep the passages clean. As the branches decrease in size, only a few scattered pieces of cartilage replace the incomplete hoops of the larger ones, till from all the smallest—the so-called bronchioles, or minute subdivisions of the terminal bronchi which singly enter each individual lobule of the lungs—have neither strengthening cartilage nor mucous glands, and might be said to be without muscular tissue. Herein lies the explanation why a bronchitis that attacks the bronchioles (often termed a capillary bronchitis) is much more serious than a

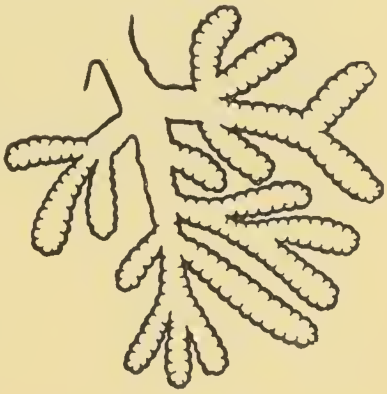


Fig. 22.—Alveoli or air-cells (diagrammatic.)
(From Warwick and Tunstall's "First-Aid to the Injured and Sick.")

bronchitis of the larger tubes, inasmuch as these small and feeble air-ducts have little power to clear themselves. Their blocked condition, interrupting as it does communication between them and the alveoli (tiny air-cells) (*Fig.* 22) amongst which they lie, interferes with that steady interchange of gases which always should go on between the cells that carry an excess of oxygen, and the blood-capillaries that carry an excess of carbonic acid gas—an interchange essential to health. Capillary bronchitis, always a serious affection, when considerable in extent may rapidly prove fatal in old people and in young children.

The apex of each lung (*Fig.* 23) reaches to just above the collar-bone, while the broad concave-shaped bases rest upon the diaphragm. On the inner side of both lungs, that is, on the sides that face each other, there is a depression known as the "root of the lungs." It is there that the bronchi and the branch nerves enter, and that the pulmonary arteries and veins pass in and out. Within the lungs the arteries run parallel with the bronchi, and from their numerous capillaries originate the veins which take back the blood to the heart. Abundant are the blood-vessels which feed the lungs, for not only do the lungs receive venous blood from the right side of the heart—blood which, when re-oxygenated by its passage through them, returns to the left auricle of the heart—but they are further supplied out

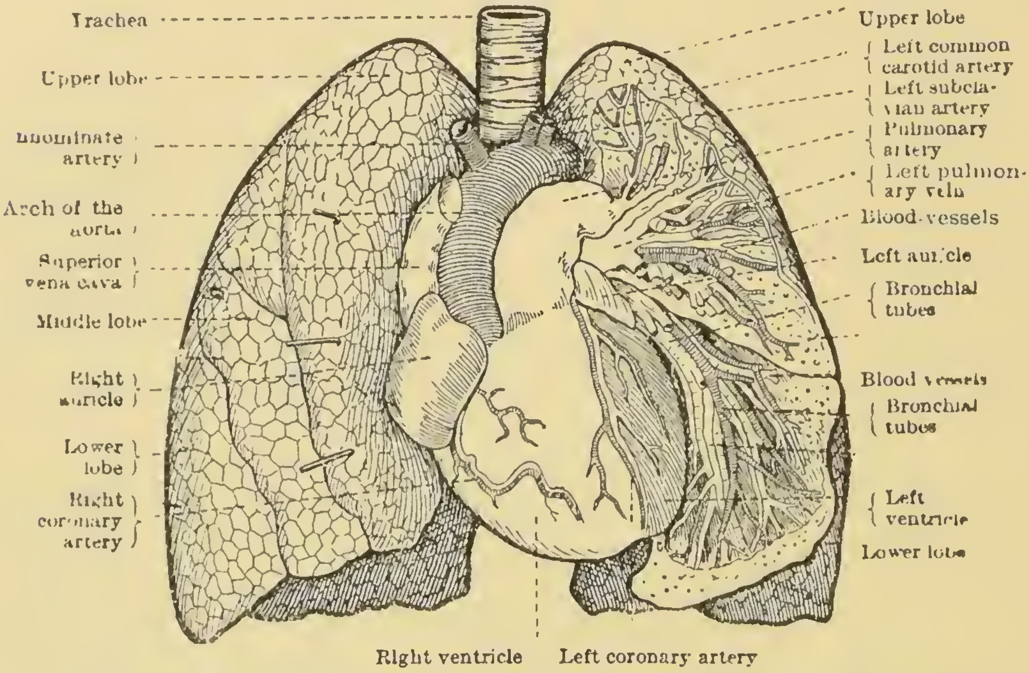


Fig. 23.—The heart, chief blood-vessels, and lungs (seen from in front).

(*From Warwick and Tunstall's "First Aid to the Injured and Sick."*)

The front portion of the left lung is cut away to show the branching of the bronchial tubes and the distribution of the blood-vessels.

of the general circulation by vessels which spring from the aorta. This double source of blood is sometimes a life-saving advantage.

The right lung differs from its neighbour in being somewhat thicker and shorter. It is shorter owing to the diaphragm being driven farther up on the right side because of the encroaching liver, which lies immediately beneath it. A further difference is that the right lung has three lobes (or major marking divisions) instead of two. The said lobes, as indeed the whole mass of the lungs, are made up of an endless number of lobules, or small bags, each of which might be looked upon as a miniature lung, for each has its own branch bronchus, branch nerve, and artery, etc.; but these lobules are not independent like the berries on a bunch of grapes, for, the adhering pulmonary layer of the pleura apart, not only do they share an all-enveloping connective-tissue sheath, but to it they owe their divisional walls, or interlobular septa, the said covering passing down between lobule and lobule, thus joining all into a spongy mass. These little lobules, some round and some oval, have their walls and inner passages—that is, the passages wherein lie their terminal bronchi and bronchioles—very closely lined by innumerable alveoli, supported by a close network of blood capillaries, and here it is that, thanks to so close a juxtaposition, that all-important interchange takes place between the excess of oxygen of the one and the excess of carbonic acid gas (or carbon dioxide) of the other. It is owing to the existence of so vast a number of lobules that there is a sufficient amount of surface to admit of so vast a number of alveoli and capillaries; just as the numerous folds and convolutions of the brain provide room enough for that world of nerves and nerve-centre cells which gives birth to all our thoughts, movements, and sensations.

You have now heard what are the passages, big and little, through which air reaches the innermost recesses of the lungs; and how the contact in the lungs of alveoli and capillaries, with naught interposing except their own fine and very pervious walls, brings about a life-maintaining interchange of gases; and whence the lungs get their abundant supply of blood-vessels. Now I have to explain how the lungs are able alternately to expand and to contract, and in so doing to receive and to expel air. Both actions are due in the main to the elastic properties of the lungs, but in every inspiration this is assisted by the extra space which the outward and upward rising of the ribs (*Fig.* 24), combined with a flattening of the arch of the diaphragm, provides for them, and in each expiration the force of the elastic recoil of the lungs is aided by renewed pressure from the descending ribs and from the uprising of the diaphragm. Further, as the balance between internal- and external-acting pressure is upset at each inspiration, there being an increase of space along with a corresponding expansion of the lungs, then in order to equalize pressure the air rushes in through the windpipe, and thus renewed tension is produced in the lungs. This process is akin to what happens when, having removed all air from a scent spray by pressure of your fingers, you relax your hold, for then air rushes in and completely fills the syringe. But so complete an emptying and filling does not take place in the lungs at each respiration, for the amount of air expelled in ordinary breathing is only a small portion of the air in the lungs and is what is called the tidal air.

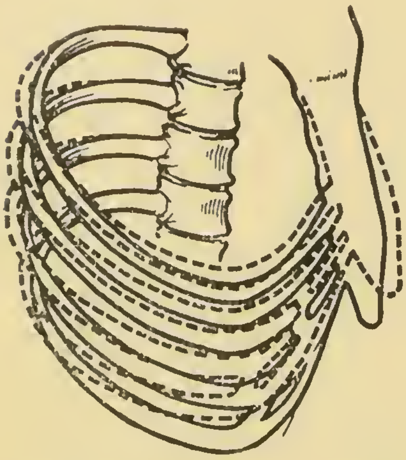


Fig. 24.—Diagram to show the movements of the ribs and sternum during respiration.

[The dotted lines indicate the position of the ribs and sternum at inspiration.]

(*From Warwick and Tunstall's "First Aid to the Injured and Sick."*)

The carrying out of the mechanical work of respiration, namely, the rise and fall of the ribs, etc., is dependent on now exciting, now controlling impulses sent from nerve centres in the medulla oblongata, supplemented by others derived from nerve centres in the spine, all of which are constantly being reversed or modified according to the messages they receive from the pulmonary and intercostal nerves. These too are much affected by excess or deficiency in the blood of oxygen or of carbon dioxide, for it has been proved beyond doubt that excess of carbon dioxide produces hurried breathing, and when very great may cause fatal exhaustion.

We must bear in mind this last fact in estimating the chances of death in cases of impaired and badly working lungs. The ribs are enabled to give a ready response to the orders sent by the brain, because, like our arms, they are provided with opposing sets of muscles, the one to lower, the other to haul them upwards, which muscles further serve to form the basket-like sides of the chest, of which the ribs are the shaping solid bars.

I must leave till the next lecture such highly dangerous lung diseases, as pneumonia and pulmonary tuberculosis, etc. I hope that what I have tried to explain to you to-day, and what I still have to tell you about these diseases, may tend to make you watchful of changes in your patients, and to be on the look-out for danger signals.

SUBJECT V continued.—LECTURE 2

PNEUMONIA—PULMONARY TUBERCULOSIS

SEEING that in last week's lecture, while directing your attention to the various parts of our air-passages, large and minute, I spoke of bronchitis as it affects the membranes of the bronchial tubes; of some dangerous diseases of the larynx; and of obstructions affecting the windpipe, which might produce suffocation, to-day I intend, during the short time at our disposal, to devote myself to two grave lung diseases which may seriously damage and endanger the construction and mechanism of the organs, namely, pneumonia, and pulmonary tuberculosis (consumption); and while dwelling on their symptoms I will try to explain to you how it is they interfere with or destroy the exercise of the all-important functions of the lungs.

Of asthma and emphysema—which latter means a dilatation of the air-cells, leading to a decrease in the contracting force of the lungs, with a consequent feebler expiration—I will not attempt to speak; nor of pleurisy, either as a primary simple inflammation of the pleural layers or as part of a general septic condition, for time does not allow, and you are not likely to have as much to do with these as with pneumonia and consumption.

PNEUMONIA.

Pneumonia is an acute feverish disease, marked by consolidation of parts of a lung, or, as in double pneumonia, of both lungs. Many cases of pneumonia, such as occur for example in an epidemic of pneumonia or as a factor of influenza, are of specific origin, the result of infection by a special micro-organism, now commonly held to be the pneumococcus. Such cases are not essentially different in their course and symptoms from pneumonia apparently due to chills, at least not more so than differences of constitution or of health conditions would naturally account for. As yet no very convincing explanation of this has been given, nor for the fact that an attendant on a person with nasal catarrh may develop an infectious form of that catarrh—certainly infectious seeing that he passes it on to his neighbours.

The differences in the types of pneumonia are very marked, varying according to which parts of the lungs are primarily or mainly attacked. It may be that it is the bronchioles and bronchi which are chiefly involved, the inflammation passing on to the alveoli, and then to the pleura; or it may be that pneumonia chiefly attacks the connective framework of the lungs—their intercrossing threads and bars as, for example, such of these as go to form the divisional interlobular walls, etc. The former, a most dangerous type, is commonest in childhood, and is known as "bronchopneumonia;" the latter as "interstitial or fibroid pneumonia." As its name implies, the latter is marked by an overgrowth of dense fibrous tissue, which in time leads to contractions and to a collapse of the alveolar tissue, sufficient to produce a perceptible flattening of the chest, while as it advances it diminishes the pulmonary functions. It is rarely a primary disease, but is commonly consequent on bronchitis or some other pulmonary affection. As a rule it progresses slowly, but none the less surely.

To serve my purpose of explaining to you how changes occur in the lungs in lung diseases, I will take typical examples of acute croupous pneumonia. Throughout the course of this serious malady—one that, if all its dangerous variants were included, would show a higher death-rate than any other hospital-treated disease, and which of late shows a rising percentage, possibly because of its being so common an accompaniment of influenza.

No doubt there are many pneumonia patients whom nothing can save owing to an extreme virulence of the disease and the extent of lung affected, or to other bad health factors complicating the case; or because pneumonia is but the last note of some other disorder, a note ever to be dreaded and watched for in the aged and in the weak. Perhaps the most frequent cause is that the aged have no recuperative force. On the other hand, recovery may result even in the worst of cases if the disease is early recognized and carefully nursed throughout all its stages. That first advantage is often lost in pneumonia patients brought into hospital, and for whom "Too Late" has to be the verdict. Not that pneumonia lacks admonitory symptoms, for its onset, instead of being marked by a series of shivering or alternate hot and cold fits as in most feverish illnesses, is marked by a sharp rigor (shiver), which in some cases—not promising ones—acts like a shock.

Following on the rigor, the first stage of this quickly advancing malady, comes a rising temperature, up to 102° to 104° F. or even higher, that tells of overcrowding of the blood (hyperæmia) has begun in the lung or lungs—most often in the lower lobe of the left lung. The direct effect of this congestion is to force out an exudate, semi-fluid in character, made up of fibres and corpuscles, interspersed by those home territorial defenders, the leucocytes. In coagulating, the exudate blocks the alveoli and their embedded neighbours, the bronchioles, and so consolidates the part attacked, making the lung seem solid to the touch, while at the same time a fine layer of lymph is laid down on the pleura. Outwardly, this trying condition is marked by a flushed red face, a highly furred tongue, and a rapid form of breathing generally accompanied by pain in the side, which causes the patient to refrain from anything like a full chest-expanding respiration. Possibly, even in mild cases, there may be slight delirium, greatly increased should the patient either have a highly-strung nervous system or have been addicted to alcohol, and it is of course still greater if the temperature is very high. It is a bad sign if a pneumonia patient seeks a somewhat raised position, for this suggests either a pleuritic effusion, from an over-distension of the capillaries, or that rarer contingency, inflammation of the covering of the heart (pericarditis).

The first stage of pneumonia may last from two to five days, or more, passing on to the second, in which the lung attains to "red hepatization," which means that the lung resembles the liver in colour and consistency. Then follows the crisis—typical of pneumonia—a sudden fall of temperature. This has not an ominous significance as in most other illnesses, in typhoid fever for example, where it would denote that dreaded catastrophe, hæmorrhage from a perforated bowel. Though this sudden fall of temperature is typical, and in favourable cases is likely to hold good, sometimes it may be gradual (by lysis), and with either there may be recurrences of higher temperatures. Where this is markedly so, it probably indicates a further spread of the malady. You will find that the attending doctors are not very anxious to reduce the fever of the first stage, unless the temperature be higher than say 103°–104° F., for fever is essential to bring about "resolution," that is, the liquefying of the consolidating exudate and the clearing of the choked and loaded lungs. Indeed it has been proved that patients with sharp fever do better as a rule than those with less, the reason with some probably being that the latter have not sufficient vitality to rush the fever and to throw off its effects.

Given the desired "resolution," the liquefied exudate is disposed of by expectoration and absorption, which latter process only involves positive septic mischief if the exudate becomes purulent (containing pus). This may be caused by inflammation failing to bring about its own reaction, or when septicæmia is engendered by a pus-making organism; then, besides pus, shreds and thread-like portions of the lung tissue may be expectorated. The colour and odour of a purulent expectoration plainly speak of its nature, while the microscope reveals its various constituents. If not freely got rid of or if the amount be extreme and the patient's condition allows of it, tapping, or even a larger opening into the chest may be practised in order to stop further infection and to relieve the lungs, should some disconnected or damaged bronchi have been rendered quite incapable of relieving the lungs by expectoration.

The sputum of pneumonia is at first clear and frothy, but gradually thickens with mucus, and in croupous pneumonia it acquires a brick-dust tint, or it may be more decidedly blood-coloured, while if the strain of hyperæmia has been extreme, capillary hæmorrhages are apt to occur.

The attending nurse would be expected to observe and report on changes in the colour and character of the sputa, ii not to preserve specimens for inspection. Once resolution has set in, the amount expectorated may be very large, in proportion to the extent of lung affected. The nurse must note any increase or decrease of breathlessness; any changes in the colour of the face, especially at night; any desire on the patient's part to be propped up, and any signs of a failing pulse. She must above all be careful, when poultices or fomentations are ordered, that they are not inadequately covered or burdensomely applied, otherwise the poor patient would be infinitely better without them and the worry they involve. If hot flannels sprinkled with turpentine are ordered, the nurse must not use so much turpentine that the skin is injured, thereby making any further relieving applications impossible. She should take great interest in the temperature charts of pneumonia cases, for its ranges are striking and significant features of this malady. Danger attaches to all the stages of pneumonia, especially as regards the heart, on which it puts a great strain; indeed, heart failure is the most frequent cause of a fatal termination, so closely do heart and lung lesions act and react on each other. The bright side of this dangerous malady is that, given an otherwise healthy subject and a favourable course, the lungs clear well and return undamaged to their normal elastic condition.

Pulmonary Tuberculosis.

This disease, still popularly called consumption, and which till recently was usually spoken of by the more learned as "phthisis," derives its name from what nowadays is recognized as its causal factor, namely, the presence and action of the *Bacillus tuberculosis*, or tubercle-producing bacillus. This knowledge has revolutionized the treatment of consumptive patients, and the good results obtained open a prospect of a decrease in the number of the victims of consumption.

Consumption is as much the outcome of an infecting micro-organism as are typhoid fever, cholera, or any other infectious disorder, but with this difference, that incubation and advance may be very slow and insidious, while the risk of infection from a stricken person to others is smaller than with most infectious diseases, provided that persons who attend on consumptive patients take proper precautions, live in good sanitary surroundings, and above all have good health.

You may perhaps ask how it can be proved that the tuberculosis bacilli cause such a chronic disease as consumption, or that they are the noxious agents in any individual case of consumption.

Many of the disease-producing micro-organisms—minute as they are—such as the *spirillum* of cholera, the *coccus* of pneumonia, and the *bacillus* of consumption, are now well recognized, and there are many standard methods for establishing their identity, such as chemical staining. In consumption, the most convincing proceeding is to take the sputum of a suspected patient, and examine it under the microscope. If tuberculosis bacilli can be detected, "cultures" are made from these, and when propagation has produced a sufficient supply, an animal is inoculated. If tubercles result in that animal, then no doubt remains, any more than when a man sows what he believes to be rye grass, and rye grass springs up. But just as the sower finds that not only rye grass but many weeds also appear, so does the laboratory examiner, or the dissector at an autopsy, find in the sputa, or in the lungs, other disease-producing micro-organisms, such as pneumococci and the pus-making staphylococci, the latter being rarely absent as most active coadjutors.

The characteristic appearance of tubercles is that of small semi-transparent nodules, often not larger than a pin-head, or if miliary, scarcely to be distinguished by the naked eye, either scattered or grouped together.

These new growths are due to the stimulus given by the virus of the bacilli, which, with the resultant inflammation, excites an overgrowth of cells in the various surrounding tissues, and in the later stages of a nodule development, more especially in the lymphatic glands. This point reached, the nodules generally pass on into a caseous (cheese-like) type of decay, ending in liquefaction through the progressive softening that follows on fatty degeneration, a result which is made evident by the quantity of heavy purulent matter coughed up. Such expectorations may or may not contain a number of bacilli. Should many tubercles coalesce and abolish divisional walls, a lung cavity of considerable size may result. Though such a cavity is locally destructive and involves loss of a portion of the breathing apparatus of the chest, if it is an isolated one and is unaccompanied by other centres of infiltration, good may follow on the lung getting rid of its purulent contents and of bacilli, for a cavity with hardened and contracted walls may cicatrize, and fever subside. If this process, however, is either over-protracted or imperfectly carried out owing to the bronchi being disconnected, then such patients suffer in general health, and their decline is thereby hastened. If well cleared, fever may stop, the disease be checked, and the patient regain flesh and health, the cavity becoming rather a landmark than a centre of evil, or it may be obliterated altogether.

Far otherwise is it when consumption starts as an acute tuberculosis of the lungs, either in its confluent form, that is, with centres spreading into other centres, along with much pneumonia-like consolidation, or with scattered caseous centres and cavities in various stages, with here and there patches of consolidation. With such patients there is much persistent fever, and death ensues in a few weeks. Mercifully, this hopeless type of consumption is not common as compared with more amenable or protracted varieties. The outcome of tubercles is not always caseation with voiding of their created cavities, for in some cases there comes a transforming fibrosis, that speaks well of the patient's resisting powers and of the likelihood of arrest of the disease. With some, this fibroid development results in complete thickening of the nodules, while with others it only forms an envelope, that imprisons alike bacilli and caseous matter.

But alas ! fibrosis cannot always be relied on to be permanent, for it has been known to break down even after thirty or forty years—not to speak of much shorter periods—and then active disease recommences.

A tendency to a general fibrosis throughout the lungs is not good, for it ends in limiting, if not in abolishing, the expanding capacity of that organ. Such a condition may follow an attack of bronchitis or of pleurisy in a consumptive patient in whom perhaps there exists a quiescent cavity, and it may increase to the extent of forming complete bands or fibroid tracts, resulting in a hardening and contraction of the affected lung along with a flattening of the corresponding portion of the chest. However, should these fibroid growths not disintegrate, and should the other lung be sound and gain in a compensating size and in strength, such a patient may none the less enjoy fair health and strength, though a breakdown and pulmonary destruction may ultimately be the cause of death. This pulmonary development of fibrosis is not the same thing as what is known as a fibroid lung, in which the pulmonary tissue becomes more or less completely fibrous, a condition commonest as a consequence of pneumonia, bronchitis, or pleurisy.

Often a sudden and a very unlooked-for event in an apparently satisfactory patient, is the reappearance of fever and other bad symptoms, telling of a rapidly-spreading general miliary tuberculosis, due in all probability to the breakdown of some lung lesion and to the spread of its purulent accompaniments—a breakdown that, where there are already damaged blood-vessels or glandular ducts, opens a far-reaching passage to infecting bacilli. Hence the rapid formation of miliary tubercles, scattered or grouped, either in an unaffected portion of the lungs, or throughout the abdominal organs, or even in the membranes of the brain (meningitis). The last disaster is not common, and is mostly confined to children, who when so affected present one of the saddest of possible spectacles.

A general miliary tuberculosis oftenest occurs as the closing stage of a long-protracted decline and in greatly damaged lungs, as is to be expected, resulting as it does from the rupture of some long-established lung lesion ; but as with hæmorrhages the unlooked-for happens at times, even so a general miliary tuberculosis may develop at an early stage of consumption, while in some cases it is apparently a primary cause. In all circumstances its progress is rapid and fatal.

Hæmoptysis (Hæmorrhage from the lungs through the mouth).—Of the many distressing symptoms that mark consumption, none is more trying or startling to nurse and patient than profuse first attacks of hæmorrhage ; not that they often cause immediate death, but they may well serve as a death-blow to already feeble lives undermined by the fire of fever.

On the other hand, where ill-working, blocked, or partly effaced lungs put so great a strain on the heart that the blood stagnates, hæmorrhages of less degree may actually prove advantageous, if not oft-repeated, owing to the relief they afford by lessening the amount of blood. Loss of blood may further serve to lower pressure or tension, thus giving to a ruptured pulmonary blood-vessel its best chance of closing. Hence, after a hæmorrhage, only very light and non-stimulating food is allowed for a time ; just as, for a like reason, a sensible householder when a breach in a water-pipe has occurred, will see that the supplying cistern does not get filled before the breach in the pipe not only has been repaired but is known to be sound enough to safely bear the pressure of the returning water. A recumbent position in bed, as few movements as possible, avoidance of all excitement, and perfect quiet, with no talking, are absolutely necessary, and if you can ensure these, you will be doing the best that can be done in the circumstances. Should you, in cottage or other private practice, have the care of such a patient, do remember these essential precautions, but never, unless conditionally directed to do so, give a stimulant, however much the patient's weakness may suggest the need of it or the patient clamour for it, for you may defeat Nature's healing efforts by so doing, and deprive your patient of his chances of recovery.

Serious pulmonary hæmorrhages are due, as a rule, either to a sudden rupture of a diseased blood-vessel, or to a dilating aneurysm that has arisen in some pulmonary branch artery owing to inflammation in its internal coats. When such a vessel lies unsupported across a lung cavity, rupture and hæmorrhage follow — possibly hæmorrhage on hæmorrhage—or a sealing thrombus (clot) may arrest further bleeding. It is owing to the forming of clots in blood-vessels during their erosion by ulceration or otherwise, that earlier and recurring hæmorrhages do not more frequently take place.

Sometimes a blood-vessel may rupture, ooze, or bleed, and yet no blood pass by the mouth. The explanation is, that where the rupture occurred the bronchioles and bronchi had already become disconnected, or were so mutilated that no available conduit remained by which the blood, or aught else, could leave the lungs. There the blood must remain, for coughing has no power to remove it. There is a like difficulty, as I have told you, in getting rid of a purulent pneumonia exudate, or of the contents of some foul secreting lung cavity. Unlike public halls and theatres, the lungs are not provided with emergency exits; nor are the bowel contents of the abdomen so constructed. Hence, if an abscess or tumour burst externally to the bowels, its contents could find no way of escape. Therefore, if peritonitis is to be fought and life saved, a surgically-made opening becomes imperative.

Pneumothorax.—In pulmonary tuberculosis, besides hæmorrhages, another sudden and most dangerous symptom may occur, one not nearly so common but which gives few and poor chances of recovery. This is pneumothorax, or pressure on the lungs by air, a condition that may arise from other causes than lung disease; but when from the latter, it implies pressure of air contained between the two layers of the pleura—the pleural cavity—owing to a passage for the air having been made by the gradual action of a tuberculous ulcer near the surface of the lung, immediately under its pleura, which finally perforates into the pleural cavity. There is a like result when an abscess in the lung points and ruptures into the pleura. When the abscess is known to exist, this escape of air will not be unexpected nor unrecognized, otherwise at first pneumothorax gives no warning, and the only outward indications are the terrified expression of the patient's face, breathlessness, increased respiration, and a slight rise of temperature, or possibly the sufferer may say he feels "as if something had broken." Later, on examination the side will appear enlarged, and the heart will be found drawn across towards the unaffected lung. Pain may be present, relievable when slight by a firm strapping of the side, but with some it is so great as to make an opiate advisable. When a patient's lung has already lost much of its size and efficiency, these symptoms are less marked, and pneumothorax causes less change of condition, so much so that its existence may remain unrealized till revealed by a post-mortem examination. Poor indeed, however, must be the state of a lung where such is the case, and poor for such patients are their chances of life!

With pneumothorax, recovery turns chiefly on the situation and the form of the induced rents and fissures—which usually are small, but of which there may be more than one at a time—and on whether or not a pleuritic effusion ensues from infection-produced inflammation reaching the pleura. The pressure of an effusion may serve to prevent any further entrance of air into the pleural cavity, and the rent in time may heal, though of course the presence of the effusion may have other injurious effects.

Before we separate, let me plainly set before you the risks of infection that attendance on advanced cases of consumption involves. They are probably somewhat greater in cottage and other private practice than in hospitals, but good health will be your best protection, while carefulness on your part and enforced attention to certain details on the part of your patient and of all others concerned, may do much towards diminishing them. Should patients in infirmary wards or in cottages, in their convulsions of coughing, be so stupidly selfish as to disregard the risk and annoyance of coughing in your face, you should appeal to the ward authorities, or yourself find means to put a stop to such ill-bred proceedings. It has been proved beyond doubt that the breath of a consumptive is not a medium of infection, so on that score you may keep your minds in peace, but it is otherwise with expectorations and what is expelled by the loose fæces of tuberculous bowels. Once these are allowed to dry, say on handkerchiefs or soiled cloths, the freed bacilli, though they cannot jump about as some terrified persons seem to think, they may be inhaled, along with the draught or wind-carried dust of a room. But even then no tuberculous crop will be bred if the involuntary invaders fall on the smooth sound membranes of the respiratory organs of a healthy person; for, as in the parable of the sower, there are grounds in which this seed either fails to spring up or fails to thrive. It is on abrasions of the nasal or throat membranes that these bacilli are most likely to rest, finding them as attractive as a wasp or a fly does an over-ripe plum with its broken oozing skin. Further, do not forget the possibility of inoculation, for doctors in making cultures from tuberculous sputa or when engaged in lung post mortems, have acquired a true tuberculosis of the skin. Make sure, therefore, that cuts or abrasions on your fingers are well protected by collodion before you handle expectoration glasses.

SUBJECT VI

BROKEN BONES AND THEIR REPAIR

LECTURE I

THE DEVELOPMENT OF BONES—A SIMPLE FRACTURE

TO-DAY I propose to speak on fractured bones and their repair; but I shall not attempt to describe all possible fractures, which vary greatly according to their position, and still more according to the nature of the accidents which caused them. My main objects are to explain how Nature works in the repair of broken bones, which repair you are called upon to forward to the best of your ability; and to show the necessity for the different treatments adopted by surgeons to bring about reunion.

I will begin with a typical simple long-bone fracture that repairs normally and well, unlike a complicated open one that if it repairs at all does so with difficulty; and in a second lecture I will speak of fractures in the flat bones of the cranium due to falls or blows on the head, drawing your attention to the inner structures of the skull, and explaining how variously the brain may be affected when violence is applied to the head.

We shall the more easily follow the process of Nature's repairing work if we first consider the structures of a bone, and how these structures develop.

Bones consist of organic (animal), and inorganic (earthy) matter. It is by reason of their fibrous matter that they are to a certain extent elastic, while the preponderance of earthy matter makes them more or less brittle, increasingly so as age advances. In some young children, especially heavy neglected ones, their bandy legs give obvious proof of how pliable are the bones in early life, they being then largely cartilaginous in character, and with little true bony tissue, only a few pieces here and there.

Bones develop out of frameworks of either connective or cartilaginous tissue, the meshes of which become filled in by hard earthy matter, they themselves either disappearing or gradually becoming hardened by impregnating phosphates and carbonates of lime, minerals with which the blood supplies our bones through the medium of bone-cells or germs, which in size resemble the white corpuscles of the blood. These minerals the blood appropriates out of the foodstuffs consumed, as acted on by inspired air and by the processes of digestion.

Of the many tissues of the body, none is so generally diffused as connective tissue in its varying types. It forms so complete a web round all our organs and other tissues, that could this web be stiffened and preserved intact when all besides had dissolved out, its parts would present the appearance of so many casts of the bones and organs which it had supported and enveloped.

Long bones, for the most part, are derived from cartilaginous moulds, but short and flat ones from those of primary connective tissue. Throughout these moulds, spreading centres of ossification develop, in some bones only one, in others several or many, and each centre has a given time of advent and location, at least in ordinary healthy subjects. A few centres ossify prior to birth, as for instance a centre in the jawbone, and one midway in the shaft of the thigh bone, the other four ossifying centres of which develop later at long intervals. These ossified parts interlock with and are upheld by the as yet unconverted cartilage till about twenty-one years of age, when the bone, its shaft and terminal epiphysis included, has become uniform in structure, no cartilage surviving beyond the ivory-like cartilage that envelops the articulating ends of a long bone. It is to their epiphyseal layers that bones owe their growth in length, for increase in that direction is due to a continuous ossification of the upper and lower surfaces of its ever-extending interposing layers, a fact proved by the cessation of growth when some inflammation-exciting disease or accident, prematurely brings about a bony union of shaft and epiphysis; or it may have the opposite effect, that of exciting to an overgrowth in length. Any unfortunate youth who has suffered in either way has to face manhood with one limb shorter than the other.

Amazingly strong as our bones are—experiments have shown them to possess double the strength of oak—they are neither solid nor compact. Long bones not only have a large central marrow-containing cavity, but they are tunnelled throughout by infinitely small canals—the "Haversian canals"—which transmit blood, lymph, and nerve fibres; and between the layers and bars of the bony matter which encircle the Haversian canals, are small spaces (lacunæ). From these issue those blood-gendered cells or germs which provide nourishment for the bone, and in childhood carry cartilage-converting material, and are also active agents in the work of bone repair.

As to the blood supply of bones, they receive it in part from vessels which pass into them by small openings in their membranous covering (the periosteum), and in part from other vessels which in long bones traverse their extremities and intercommunicate with the periosteum-derived vessels. Hence it is that, though the shaft of a bone may have necrosed owing to some injury having destroyed its periosteum, the extremities may survive intact, while if regrowth of periosteum occurs, it will give birth to fresh bone sufficient to surround the dead section.

The ivory-like cartilage at the ends of articulating bones has no such direct supply nor is it furnished with nerves, but, strong as the shaft and more elastic, it is particularly adapted to act, as it does, the part of a buffer to the joints, and this, combined with the lubricating fluid constantly secreted by the synovial membrane which lines the joints, furnishes bone ends and tendons with the smoothest of surfaces on which to play. But for the rest it is with the periosteum that ligaments and tendons connect, passing through it to their points of attachment on the bones whereon they exercise their constraining powers. This explains how when a sprain wrenches the muscles concerned with so great a force as to fracture the bone to which they are attached, some portion of the periosteum may be torn off, and consequently reunion does not take place for a time, if at all, because that bone has been in part divested of its blood-nursing covering. It might also happen that the piece of periosteum which was torn off lies obstructingly between the two ends, so preventing reunion.

How Bones are Fractured.

Firstly, a bone may be fractured through muscular action, that is, by a sudden contraction of a muscle or muscles causing the bone into which they are inserted to snap. These fractures occur oftenest in the knee-cap and elbow joint, and occasionally in the breast-bone and pelvis, but rarely in long bones.

Secondly, by direct force, such as a blow or kick, at the point struck, or from a part being crushed.

Thirdly, by indirect violence ; that is, the bone gives way at its weakest point, when damaging force is applied to its ends. Examples of this kind are : Fracture of the collar bone, caused by a fall on the hands or the shoulder ; a fracture of the tibia above the ankle—its weakest point—through jumping from a height on to the feet. To these might be added the almost unaccountable fractures which a slight strain or knock will cause in persons whose bones are abnormally brittle. This characteristic may be hereditary, and may rule in all the members of a family.

DIFFERENT FORMS OF FRACTURES.

It is well you should know the names surgeons use for various bone fractures. They are :—

1. *Simple.* When a bone is broken but there is no external wound.

2. *Compound.* A fracture which is in communication with the external air through a wound of the overlying parts. "Simple" and "Compound" fractures are sometimes called "Open" and "Closed," terms that seem more distinctive than simple and compound.

3. *Single.* With only one line of fracture.

4. *Multiple.* With two or more lines of fracture.

5. *Comminuted.* When the bone is splintered.

6. *Compound and Comminuted.* A condition likely to occur when a wheel, or anything heavy, passes over a limb.

7. *Incomplete.* When a bone is not broken through. An incomplete fracture may be either "starred" (many fissures radiating from one point), or a "greenstick" or a "willow" fracture (the bone broken on one side and bent on the other). This last occurs in young and rickety bones.

8. *Complete.* One in which the bone is entirely broken.

The signs which indicate the fracture of a bone are :—Powerlessness of the damaged limb ; distortions, swellings, and pain ; abnormal mobility if moved by hand ; "crepitus," or a grating sound, produced by the ends rubbing against each other. Absence of crepitus, however, does not necessarily imply that a bone is not fractured, for it would not be present if there were impaction, or if a muscle or a piece of the periosteum were interposed.

Varieties of Direction in Complete Fractures.—A complete fracture may be transverse, longitudinal, oblique, or spiral. The first two are rare, but every degree of oblique fracture is common.

SIMPLE FRACTURE OF THE FEMUR.

I will take as an example of this fracture a man with a simple (closed) fracture of the shaft of the thigh bone (the femur), about half way between the hip and the knee—not complicated, because the joints were not affected and he had the good sense not to attempt to stand up after the accident. Fortunately, too, no ill-advised friends or spectators, keen to prove their sympathy, had tried to "get him up," and so he had been saved that bad complication, a compound or open fracture, which might easily have been his fate had he stood up and so forced one of the broken ends of bone through the flesh. Of compound fractures

I will speak later, referring to a case I saw here not long ago.

We will suppose that a well-instructed policeman has safely conveyed our man on a stretcher to the nearest hospital, after applying a long stick from under the arm to beyond the ankle of the damaged limb, with shorter splints on its inner side and over the leg (*Fig.* 25). The policeman used a long splint because in "First Aid to the Wounded" instruction classes, it had been impressed on him that with a fractured thigh bone, unless the long back and thigh muscles are thus rendered incapable of carrying on their ordinary work, that of pulling upon the femur and the knee to which they are attached, they may prevent the broken bone being kept at rest and drag its ends farther apart.

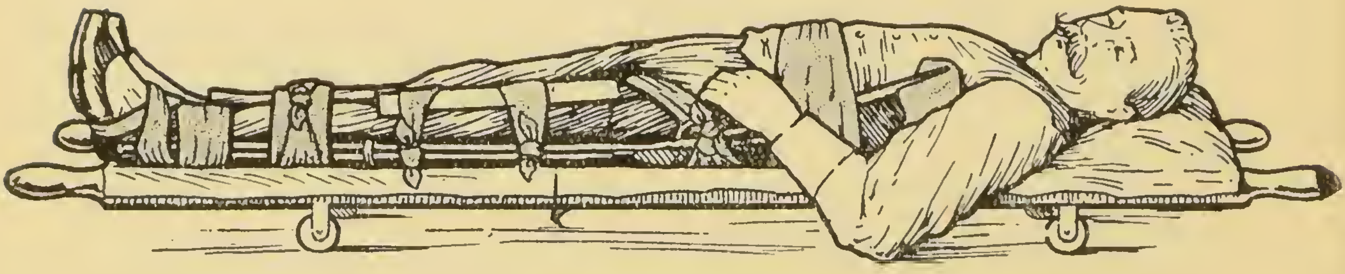


Fig. 25.—Fracture of the thigh put up by means of long and short splints.
(*From Warwick and Tunstall's "First Aid to the Injured and Sick."*)

Nor could a short side or upper splint correct the inevitable helpless turning of the foot outwards or inwards, according to the direction of the line of fracture.

When a fracture of the thigh bone has been demonstrated, the aims of the surgeon and all concerned are first to get the fractured ends opposite each other and as close as possible, and to have the whole limb advantageously placed, and secondly, by the help of an apparatus, to ensure immobilization of the joint.

On arrival at the hospital, it would probably be found that the leg was too much swollen by extravasated blood to permit of immediate "setting." While waiting for a certain amount of that blood to become absorbed, the policeman's temporary arrangement might be continued, aided by sandbags, or might be replaced by these. Indeed, in the most modern treatment of simple fractures, sandbags, and plaster splints in two halves, removable and replaceable at will, along with early massage and passive movements, qualify,* if they do not replace, the retentive appliances of older systems. The newer system shortens the length of confinement and, what is more valuable, largely prevents the development of adhesion bands, stiffening of joints, and wasting of muscles, evils that too often resulted from the older forms of treatment, which also, by checking the circulation of the blood, not only retarded the reunion aimed at but induced bedsores and even gangrene. On the other hand, unless circumstances allow of the surgeon constantly attending the case, and unless he or a qualified masseur practises the movements and massage, the risk of repeated misplacements is great, with resulting disfigurement if not impairment of the limb's usefulness.

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* See Sir W. Bennett on "The Present Position of the Treatment of Simple Fractures."

Some skilled surgeons deal operatively with long-bone fractures when the line of fracture is markedly oblique or spiral, or with a fractured patella or olecranon (the projecting process of the ulna); that is, they lay bare the bone and then bring the broken parts together by silver wire passed through the broken ends or sides, or by silk thread wound round implanted transfixion pins, if such are used. When a fracture of the patella is such as to make apposition impossible, operative treatment is called for. But such measures are not free from risks and disadvantages, for Nature is not always tolerant of the adjusting agents, however aseptic, and sometimes treats them as foreign bodies, ejecting them by suppuration.

To return to our case of a fractured femur. Whatever method be adopted later, in the first days after reduction immobility will probably be provided for by means of a long T-shaped back and foot splint, while the required extension to prevent shortening of the limb, and a resisting influence to counteract the disposition of the foot to turn outwards or inwards, are met by the use of a pulley and weights, the attaching cord of which is passed through a cross-footbar clear of the bed, measures being taken to make it bear on the leg.

Further, in all treatments of thigh fractures, great importance is attached to the patient's body being so placed that it acts the part of an extension weight on the upper broken end of the thigh bone, and to the broken ends being made to fall naturally into their places by a slight bending of the limb. These advantageous conditions can generally be secured by the simple expedient of raising the foot of the bed a few inches.

Likewise, in cases of a fractured humerus much can be done by making use of the weight of the arm to prevent the lower half of the broken shaft over-riding the upper. For this, the elbow must be left unsupported, while the wrist is carried in a narrow scarf-sling, and at the same time the shoulder should be forced somewhat upwards by means of a thick well-adjusted pad firmly bound within the armpit (*Fig.* 26). With a fractured collar-bone the reverse is done, for in order to prevent the weight of the arm dragging on the collar-bone, the elbow is well supported by a broad triangular bandage (*Fig.* 27).

I will not describe how a pulley-and-weight extension apparatus is made to bear on the leg by connecting straight and encircling strips of strapping, nor how movable plaster splints in two halves are made, for you will understand these better by examining them, and moreover, the details vary according to the surgeon's individual preferences or the necessities of the case.

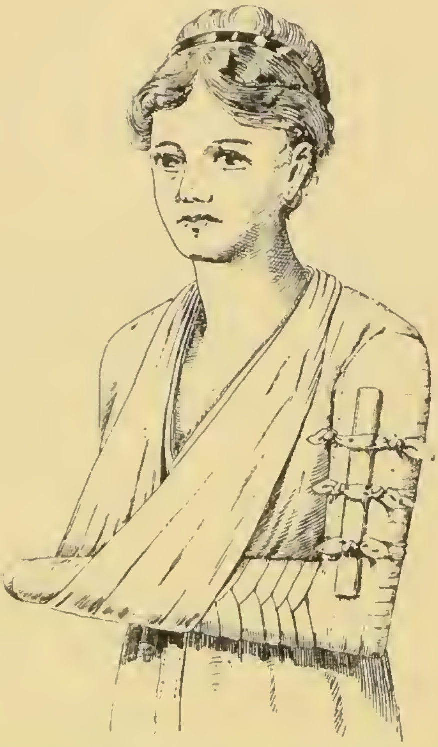

Fig. 26.—To show the method of putting up a broken humerus, with the elbow unsupported.

Let us consider for a few minutes how Nature works in bringing about reunion of bone in a healthy person. She works much as in a flesh wound, only it takes longer, and she has to repeat some of the processes; also she has greatly to depend on a true adjustment of the broken ends. The surgeon reduces the fracture under an anæsthetic, which not only saves the patient from pain but aids the surgeon by relaxing muscular tension. You will remember that the limb was swollen by extravasated blood that came not only from surrounding fleshy tissues but from the bone itself and its periosteum. Much of this blood is absorbed, while to the residue are added certain products of inflammation, till ere long the bone becomes externally surrounded and internally filled by soft pink granulation tissue—"plastic lymph"—to which the renewing layers of the periosteum act like a bandage. This plastic lymph consists of fibrous tissues, fresh loops of blood capillaries, and white blood corpuscles, and it carries bone germs (osteoblasts). Here we have an instance of how inflammation, so often considered an unmixed evil, sometimes works for good, for this invaluable lymph is substantially a product of inflammation, and hence the explanation of why, when union is not being gained, friction is applied to the ends of a broken bone to induce inflammation. In about two weeks' time the lymph is of such a consistency that the bone may be said to stick in it as it might in sealing-wax, and in from six to eight weeks ossification will have converted the plastic lymph into "temporary callus," so called because it gives place to a permanent callus, which does not however become complete much under a year.

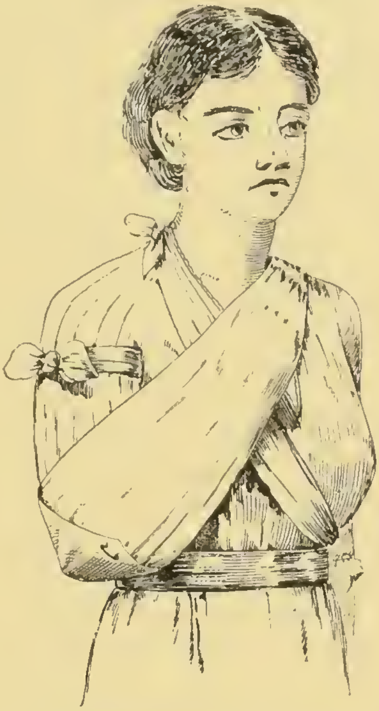

Fig. 27.—Method of bandaging for a broken collar bone, with elbow well supported by a broad bandage.

At the next lecture I will speak of a worse form of long-bone fracture, and of fractures of the bones of the skull.

SUBJECT VI continued.—LECTURE 2

THE HISTORY OF A COMMINUTED OPEN FRACTURE—SKULL FRACTURES

OUR last lecture closed with the repair of a simple, or closed, fracture. To-day, before describing a serious case of comminuted open fracture, I will first touch upon hip fractures, because they are so common in the aged, especially in old women. A fall on the floor when the foot has caught in a rug or a hole in the carpet, is sufficient in an elderly person to cause a hip fracture, while a fall from a horse or a high dogcart on to a hard road may have a like result in young people. The fracture may be either in the ball of the femur, in its prominent angle (the great trochanter) or, far oftener, in the neck of the femur. (*Fig.* 28.) In the latter the broken ends may or may not impact. If impaction takes place continuity, such as it is, is preserved in the thigh bone; by no means a small advantage, as non-impacted hip fractures seldom unite well. Fractures near the head of the femur do not impact so often as fractures near the trochanter.

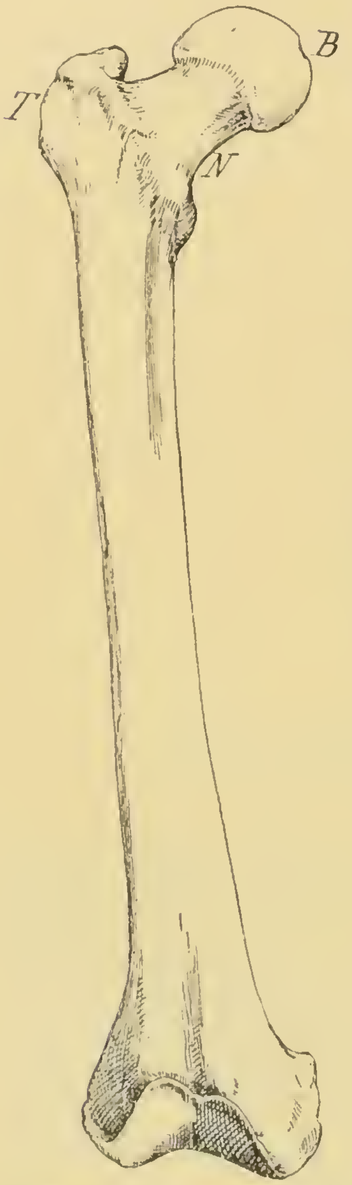

Fig. 28.—The femur (posterior aspect).
B, head; *N*, neck; *T*, great trochanter.

In these fractures there is always reversion, that is, the foot turns either inwards or outwards, according to whether impaction holds in the anterior or in the posterior side of the femoral neck, and more or less shortening of the leg also follows. In favourable cases, the resulting lameness may be slight, in others, crutches or at least a stick becomes necessary, while in some there is total disablement. For persons under middle age and whose vitality promises well for ultimate reunion, a diminished deformity, and a consequent better use of the limb, are to be gained by submitting to refracture in order to allow of better adjustment.

In the aged and the feeble, hip fractures frequently prove fatal, in consequence of the shock caused by the fall, the seriousness of which may show itself in a low form of pneumonia ; or because of the bad effects of a constraining position or of exhausting bedsores. Indeed, so badly do elderly persons bear splints or protracted immobility, that surgeons often have to forego regulation retention appliances, and to sanction changes of position. On the other hand, for younger patients with non-impacted hip fractures, and where there is reasonable hope of more than a fibrous union, there are numerous appliances to ensure immobility pending Nature's repairing work. Modern surgery tends to lessen the period of immobilization. Whatever the method of treatment adopted, such cases make great demands on a nurse's attention, for she must see that the patient's skin is not injured by the undue pressure of a splint or by an unchanged position, and she must report any signs of arrested circulation, such as may be produced by a too tight bandage or by the insufficient padding of an extensive plaster covering, for she must remember that she shares with the attending surgeon the responsibility of possible gangrene from arrested circulation. She must always be on the look out for red pressure spots, and have their exciting cause removed, giving special attention to the heels, for on these lesions in the skin most readily occur, and spread rapidly. Circumstances may allow of the surgeon swinging the foot in a bandage, to avoid all pressure ; but failing this, much can be done not only for the heels but for all projecting parts of the body that are subjected to pressure, by a judicious use of hollowed-out circular pads, or nests. With regard to the skin, I cannot too strongly impress upon you the value of the two great safeguards, cleanliness and absolute dryness, for damp tends to soften the skin and thus lessens its powers of resistance. Hence, after a soap and water cleansing, the parts of the body not encased in bandages should be lightly rubbed with some spirit and finally dusted with a zinc or other powder, for nothing so ensures complete dryness as powder.

An Open Comminuted Fracture.

The case of John B. suggested the worst possibilities, seeing, in the first place, how badly the bones in the lower half of the leg were broken, and how large an area of skin and muscles had been torn by the heavy cartwheel which had passed over his leg, forwards and backwards according to the movements of the frightened horse. In addition, the wound was sadly fouled by dirt from the road, while shreds of soiled clothing had been pressed into it, conditions calculated to give rise to tetanus, cellulitis, or septicæmia. Further, besides the main fractures in both bones, fragments had been broken off the tibia, which, being the more projecting and the least protected of the two, suffered most. Fortunately no serious damage had been done to their extremities (the malleoli), nor had the back tendon suffered. Finally, considering how severely crushed the limb was, it might well be that an important vein or artery, or both (since the larger veins and arteries lie close together), had been either rent or stretched, or had become choked by a blood-clot, any of which evils, by stopping the passage of the blood, might cause gangrene.

The first thing the nurses did when at last John B. was brought into hospital—for delay was one of the bad factors in his case—was, after removing all clothing, to bathe the leg with boiled water till all surface dirt had been removed from the oozing wound, which extended across the limb from close to the knee down towards the ankle. Before applying an antiseptic dressing, the wound was sponged with an antiseptic lotion, and then the leg was placed by the help of sandbags in as favourable a position as possible to await the surgeon.

The first thing our French neighbours would have done as a matter of routine would have been to inject some anti-tetanus serum, to try and prevent tetanus, always a contingency when a wound comes into contact with dirt; but in England this is not as yet an established practice, and the results on human subjects have not hitherto encouraged our surgeons to make it so. Success depends to a large extent, as with anti-diphtheria serum, on the serum being administered before the infecting element has attained to its second and most dangerous stage.

Before inspection of the limb by the surgeon, John B. was put under an anæsthetic, for the wound had to be thoroughly cleansed, all coagulated blood removed, and the wound enlarged so as to enable the surgeon to ascertain the condition of the shattered bones—whether necrosis threatened, or removal of detached fragments was necessary. His decision as to amputation would depend to a certain extent on how far the long-exposed fleshy parts, sodden with blood as they were, had become unsound, but mainly on whether or not pulsation could be felt beyond the wound in the arteries round the ankle. Fortunately for John B., this proved to be the case, and undamaged too were the muscles and tendons at the back of the leg. Hence he was not fated to leave hospital minus half a leg, though a doubtful fragment of bone had to be removed. Good apposition was also impossible, for with so deeply fouled a wound the probability of infecting micro-organisms attacking the bones was too great to allow of an attempt at ensuring a better apposition and the hastening of union by the use of wires or plates. To do so would have been to risk inflammation, with ensuing suppuration. Such success as was achieved was due to the use of a skilfully constructed well-padded back splint, and the means employed to keep the foot in the right plane with the knee while the flesh wound slowly healed. But long was it ere a fibrous union without temporary callus turned into a stronger and more serviceable one.

I have dwelt on this case in order to impress upon you what it is that makes all open fractures so much more serious than closed ones, even when the latter are purposely converted into open fractures to allow of wiring, etc., say of a spiral fracture or a gaping knee-cap, for with these the risk to the bone is comparatively small, owing to the strict antiseptic precautions taken and the short time a surgically-made wound is exposed to the air or to any other sources of infection.

FRACTURES OF THE CRANIUM.

In speaking of skull fractures, I shall have to limit myself to those resulting from a fall or a blow on the head, with their disastrous consequences, for part of our time must unavoidably be spent in directing your attention to the position and characteristics of the bones which compose the cranium, with a view to making you understand why some of these bones fracture more readily than do others; why, from their position, some fractures are very dangerous; and why it often happens in injuries to the base of the skull that blood escapes through the ears, eyes, or nose, or through all three.

Your charts show clearly the shape and position of the six main cranial bones, with their sutures and the larger foramina (apertures or holes), and the plates also give you the shape of the two lesser bones—the sphenoid and the ethmoid; but they do not show the relative position of these two smaller but structurally important bones, nor do the charts make it sufficiently obvious how far the cranial bones vary in thickness and strength.

Broadly speaking, one might liken cranial fractures to what happens when a semi-boiled egg has had a sharp tap on some spot, or has had, like Humpty Dumpty, " a sad fall," or has been subjected to pressure. In the first case, the shell would be indented; in the second and third, a fracture, with possible protrusion of some of the contents, would be the result. Beyond this point analogy fails, seeing that an egg-shell has none of the elasticity of cranial bones, nor on the other hand have cranial bones internally the smoothness of the egg-shell, nor even that comparative evenness of their external aspect, which reveals so little of the form and course of the convolutions of the brain that they protectingly cover.

Internally, the cranium in its ridges, prominences, and depressions (fossæ) bears the impress of the larger masses and of the deepest divisions (sulci) of the brain. Its grooves and fissures, which serve as canals and passages and outlets to cerebral nerves and blood-vessels, are numerous, and so are foramina of all sizes. The largest of the foramina is the one at the base of the skull, close to where the occipital bone articulates with the first of the spinal vertebræ (the atlas), and which there admits the medulla oblongata—that connecting link between the spinal cord and the brain—along with various important nerves. The next largest are the orifices of the ear-passages and those which provide entrance and exit for the great blood-vessels that pass to and from the head.

With regard to the strength of the cranium, the parallel must be drawn not with an egg-shell but with an arched building with its strengthening buttresses and groins, for the vault of the cranium has in like manner supporting buttresses and ribs. The largest and most marked of the latter is that which starts in the centre of the frontal bone, and passes uninterruptedly to the great foramen at the base of the skull, and which is crossed at a right angle by another that traverses the occipital bone. As their centre the cranial arches have the body of the sphenoid, while their main front buttresses are the cheek bones and the wing of the sphenoid, and as main posterior buttress the occipital bone, besides other bones which afford additional supports. It is owing to this system of buttresses, and to the tendency of a shock to pass from the site of a fracture caused by blows on to the supporting piers of the bone, that a lessened shock comes to be given elsewhere with resulting fissures. This in part explains why fissures at the base of the skull so often follow on crown injuries, even if there be no fracture where the crown was struck.

As a building has its weak places, say its windows and openings for conduits, so the cranium has its weak points in the apertures I have mentioned, and in the thinness of some of its bones, or portions of them. The three portions of the temporal bone afford a striking example of differences in strength in an individual bone, for the uppermost portion (the squamous, so called from its scale-like appearance) is so thin that very little force will break it, whereas the lowest portion (the petrous) is intensely hard, as anyone who has heard a surgeon's instruments at work on it cannot fail to realize. Far back in this stone-like portion, which extends to the base of the skull, lie embedded the nerves of hearing, and the canals of the curiously shaped "bony labyrinth" of the ear, which, together with the tympanum, considerably encroach on the thickness of the said portion. Further, it is pierced by orifices for the ear-passages, for the Fallopian canal which carries the facial nerve, and for the carotid and jugular blood-vessels, along with many minor foramina, all creating breaches in this part of the cranial walls and providing easy outlets for the blood of hæmorrhages that result from accidents.

Not much strengthening support is supplied by the thin bat-shaped sphenoid, except where it is wedged into the base of the skull, and even less by the delicate spongy ethmoid ; yet these two bones not only provide an elaborate additional framework to the cranium, but have their share in the formation of other parts of the skull, namely, the palate and the bony sockets of the eyes. The ethmoid also forms the divisional wall of the nose. And inasmuch as they articulate with all the cranial and with many of the facial bones, the sphenoid and the ethmoid serve to a certain extent to unite the back and front halves of the skull, and through their numerous folds, fissures, and canals, provide communicating passages for nerves and blood-vessels. For example, it is in a passage in the ethmoid that the nerve of smell expands, while it is the sphenoid that transmits to the eyes some of the optic nerves and their blood-feeding vessels.

It is not difficult to imagine what would be the effects of a strong jarring concussion on the skull and its delicate structures—effects not unlike those of an earthquake on a house, cracked walls and water-pipes, and water, if unable to find an outlet, flooding the house. Even so, in bad cases consequent on excessive violence applied to the cranium, there may be protrusion of the brain substance or exudation of serum at the ears, or more commonly hæmorrhages which, if they find no outlet, either flood some part of the brain causing apoplexy, or it gradually accumulates and acts as a brain-compressing weight.

The skulls of infants and young children often successfully resist what in adults would cause fractures, owing to the greater elasticity of their cranial bones, and to the fact that their sutures are held together only by a more or less fibrous membrane ; still, if subjected to extreme violence they will fracture, and even when no fracture or hæmorrhage is apparent, some time must elapse before it can be confidently asserted that the brain has not been damaged in any way. One hears from time to time of luckless babes whose intelligence does not develop, or whose small legs hang powerlessly down, unaccountably so it is thought, but possibly the result of an accident which a nurse for reasons of her own had not thought fit to report. Only the other day as I was driving I saw a nurse, unobservant of the ill-balanced position of her small white-faced charge in its smart high-swung perambulator, push the perambulator so recklessly across a break in the pavement that it turned right over, with the child underneath.

A friendly policeman went to the rescue, so I did not interfere, but I wondered much if this valuable nurse would report the incident on her return to the child's home.

Like other flat bones, the cranial bones are composed of three layers, or tables, differing in consistency. The outermost is tough, like wood, the innermost is somewhat like glass, while the intermediate layer (the diploë), with its cancellous tissue and abundant provision of blood-vessels, is more or less spongy, and as such serves to deaden the force of a blow. So brittle is the innermost plate, that sometimes it is fractured when the outermost remains intact, and concussions also sometimes lead to a bloody oozing from the diploë—two evils difficult to recognize till revealed by their resultant symptoms.

Skull fractures differ greatly in seriousness and character even when they have a common origin—such as a blow or fall on the head—according to their position and the force causing them. As in long-bone fractures, they may be closed, or open (when in addition to the fracture the scalp is cut or torn), complete or incomplete, comminuted or fissured. Another kind of fracture, impossible in long bones, and due to the nature of the brain-containing skull and the elasticity of its bones, is one that may be indirectly brought about from within. Such a fracture occurs when the head is strongly compressed on both sides, as may happen in a machinery or railway accident, because when thus narrowed by pressure it bulgingly expands in another direction, with such an overstraining of the elasticity of the bones that a rending or bursting fracture results. The same is the case when a strong diffused force is applied to any part of the head, though unlike fractures consequent on bilateral pressure, the fractures occur at the part struck and not in an opposite direction. Such cases are commoner than the former. To realize the nature of these fractures, think of an orange lying on the pavement, heavily squeezed by a passing foot, or one thrown violently against a wall by a boy, just as he would throw a ball at fives, or one broadly struck by another boy. In all these cases the orange would alter in shape, and with the alteration some overstrained part of its rind would burst. But the bursting of the rind is not followed by that striking feature of some similar skull fractures, namely, their self-closure when pressure or force has ceased to act. So sharp sometimes is the snap with which these fractures close, that hair or a piece of a closely fitting cap may be caught in between the edges, thus telling how great is the elasticity of the cranial bones as compared with the inert rind of an orange or the brittle shell of an egg.

As regards the position of injuries to the head, those that affect the base of the skull are unquestionably the most dangerous and the least amenable to surgical treatment, for below the base of the skull, in the medulla, lie the important nerves and nerve centres which rule the heart and the respiratory organs. But disastrous, too, may be the results of injuries to the sides or crown of the head, or consequent paralysis or hæmorrhage depending on which of the brain circles or what spot in the cortex has been injured, and on whether some of the blood-vessels of the membrane (meningeal) have been cut or not. A boxer's powerful blow on the face may not only break the nose bones of the victim, but may shatter the delicate ethmoid, even to its doubling back to the base of the skull, and thus indirectly causes an injury there, and not improbably the sphenoid would also be damaged. While from the base blood would flow from the nose via the nasal air cavities in the terminal part of the sphenoid, which bone, as I told you, has its origin in the base of the skull within the occipital bone.

Concussion and Compression of the Brain.

From what I have pictured to you of the inner structures of the skull and of the course of its connecting blood- and nerve-carrying canals, I hope that when, consequent on a head accident, you see blood escaping from a nose or an ear which has not directly suffered, the explanation of this symptom may suggest itself to you; and that you will also understand how much more serious is unconsciousness due to compression of the brain than unconsciousness resulting from brain concussion. In concussion, the jar to the brain usually causes temporary unconsciousness, whereas the continued unconsciousness of compression of the brain implies that the lesion in the brain caused by a blow or fall has induced pressure on the brain, whether from accumulated blood, serum, a clot, or a piece of indriven bone. To make recovery possible, such pressure must be relieved by surgical means. When a person rendered unconscious by a blow or fall on the head recovers consciousness and after a lucid interval relapses into unconsciousness, advancing pressure is clearly indicated, but there may be no lucid interval if the first unconsciousness has not passed off before that due to compression sets in.

I must speak to you another time of the surgical means employed to remove pressure, and of the serious responsibilities of a nurse in charge of a patient who is unconscious, and possibly more or less paralysed, through some accident affecting the head.

SUBJECT VII

BACTERIOLOGY

LECTURE I

"THE WORLD OF THE INFINITELY SMALL."

OUR subject to-day is concerned with what has been aptly called "The world of the infinitely small," that is, the world of numberless and ever-present micro-organisms, popularly known as microbes, more especially those which are disease producers (pathogenic); and with the means so far discovered for fighting them.

You may perhaps be inclined to regard this subject as dry or perplexing, but I hope you may not find it so, as all I propose to do is to give a simple account of the nature, habits, and properties of our microscopic foes, together with the story of the revelation of their existence and of the discovery of the means of defending ourselves against them, leaving that story to supply you with an obvious explanation of the necessity for the antiseptics you use and the elaborate precautions now taken by careful surgeons against infecting micro-organisms.

To me this subject, in some of its aspects, is as interesting and as weird as were the favourite fairy and hobgoblin tales of our childhood, to some of which they offer a fair counterpart. I refer to such stories as "Jack the Giant-Killer"; to the evil genii who spread plague and pestilence; to the fairies riding through the air in their cobweb chariots; to the story of the kindly imp who completed the work the girl could not accomplish; to the magician doctor of folk-lore fame; and to the wicked fairy witches, capable of rolling themselves into a ball and so squeezing through keyholes, and of knocking over their victims with their poisonous wands. For example, might not the little typhoid bacillus that pierces the human intestines and causes giant man to bleed to death, stand for Jack the Giant-Killer? And does not the clever imp who accomplished an apparently hopeless task suggest the wonderful microbe that can perform the feat of converting vats of dull malt into foaming beer, or flat grape-juice into sparkling wine? Might we not compare our dear fairies, flying hither and thither in cobweb chariots, to the fine microbe-laden particles of dust which a bright ray of sunlight in an otherwise darkened room reveals to us, whirling, dancing, and intercrossing? And may we not in the wondrous feats of the magician doctor see a forecast of the marvels of artificially-created immunization? Finally, may we not liken the wicked fairy witches to the cruel pus-provoking microbes, such adepts at squeezing themselves through hole and crevice or down a gutta-percha tube, or so treacherously clinging all unseen to the surgeon's knife or needle, and thus, unless these be made too hot for them, forcing a way through fleshy walls into vulnerable parts, there to poison and undermine?

Till it was recognized that the air is generally laden with foes, and that suppuration and gangrene in wounds were due to their action, surgeons did not know how to prevent these all too frequently fatal results in operations—results which in times of war were responsible for more deaths than were the bullets or the bayonet-thrusts of the enemy. Nowadays, in all cases of operations or of open sores the combined efforts of surgeons and of trained nurses are directed towards securing aseptic conditions, that is, the exclusion of all microbes. The choice of means rests on what wide research and great experience have proved the safest and most effectual. For example, surgeons now use layers of cotton-wool on wounds, not only to block ingress but as filters to entrap all intruding microbes (I place this detail first because I shall have more to say about cotton-wool). Then there is the now invariable practice of boiling or passing through a flame all instruments before they are used, and the boiling, steaming, or treating with antimicrobic chemicals of all required appliances, together with the removal, well before operation, of all dust in the operating-room, lest some current of air during the operation should set it in motion, and thus allow of microbes reaching the wound. Further, the body of the patient is thoroughly cleansed, naturally and chemically, as are the hands of the surgeons and nurses and any rubber gloves used. With these precautions there is every reasonable hope that operations may be performed, and the consequent wound maintained, free of infection. Such a condition, too, is the most favourable to healing because, valuable in many ways as are antiseptics, they cannot be regarded as the best things wherewith to treat raw surfaces, seeing that they are, or at least we hope they are, injurious to microbes whose composition after all is akin to ours. In fact some antiseptics are highly irritating, and even poisonous, to the tissues of some persons, hence great is the problem how to produce antiseptics strong enough to kill spores, which are harder to kill than the parent microbes, and at the same time not hurtful to human beings.

Should the condition of a wound, either by a rise of temperature or otherwise, indicate the presence of microbic infection, antiseptics must at once be resorted to, but with no relaxation in the efforts to keep up a thorough aseptic condition, in order to prevent any increased infection. Recourse to antiseptics must also be had where unfavourable local circumstances render it improbable that asepsis can really be maintained.

The difference between asepsis and antiseptics might be expressed by the difference between a successful opposition to the entrance of a murderously disposed robber and the knocking him over when he has forced his way in; while sepsis might stand for the wretched householder hopelessly assaulted by the robber. It is important you should thoroughly understand the difference between the three terms, septic, that is, infected; aseptic, non-infected; and antiseptics, agents, usually chemical ones, that are used to stop a further development of infection.

Bacteria.

Leaving such tiny fancy-bred objects as imps and fairies, we must now pass to still smaller objects—micro-organisms—objects that, in spite of their microscopic size are none the less living, and when pathogenic (disease-producing), living evil realities.

Bacteria is the general term applied to-day to the one-celled or simplest forms of life in the vegetable world. The lowest type in the scale of these multiply by fission, that is, by self-division, though some of them also multiply occasionally by growing and throwing off spores, which develop into true bacteria.

Among the lowest types are the three following classes: (1) Cocci; (2) Bacilli; (3) Spirilla. I want especially to direct your attention to these, because it is to them that are due so many of those serious diseases, the victims of which you have to nurse.

1. Cocci in shape are round or dot-like. They are sometimes to be seen scattered singly, but more often adhering together in twos or more, sometimes in such numbers that the cluster suggests a bunch of grapes. *Plate I* shows two kinds of cocci, namely, the diplococcus of pneumonia (*Fig.* 3), and the *Streptococcus pyogenes* (or, pus-producing) (*Fig.* 4).

2. The bacillus cell is rod-shaped, and its length is twice as great as its width. These cells tend to convert themselves into chains within their covering sheath. *Plate I, Fig.* 1, shows the diphtheria bacillus, and *Fig.* 2 the tuberculosis bacillus.

3. The spirilla owe their spiral or wavy appearance to their cells which, are comma-like in shape, producing that effect when they are joined to each other. *Plate I, Fig.* 5, shows the spirillum of Asiatic cholera.

These illustrations all show the different bacteria in their typical condition, for they vary considerably in shape when

PLATE 1

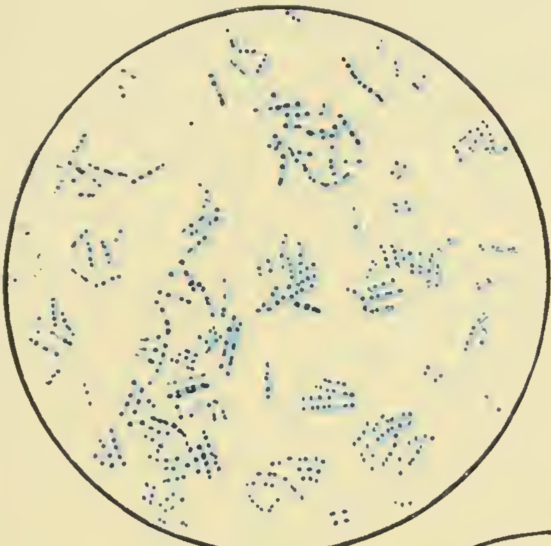

Fig. 1

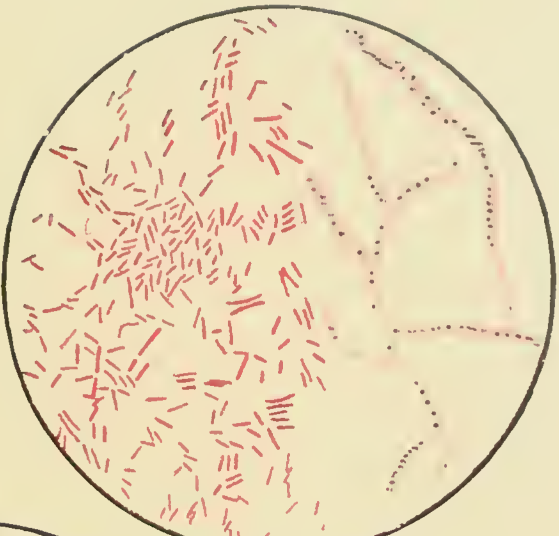

Fig. 2

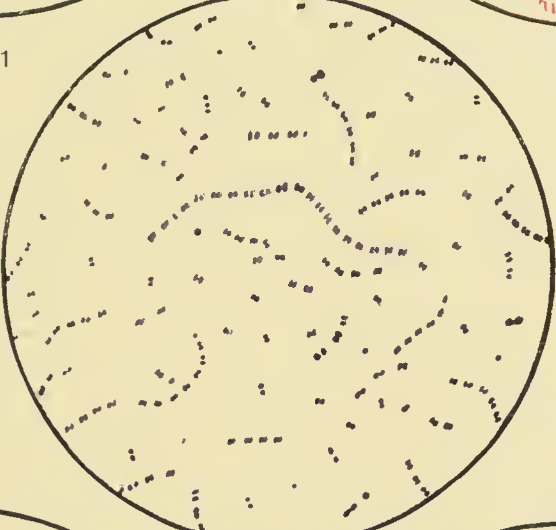

Fig. 3

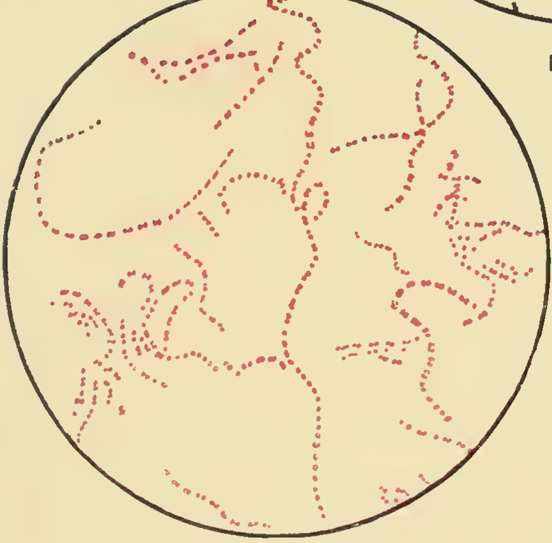

Fig. 4

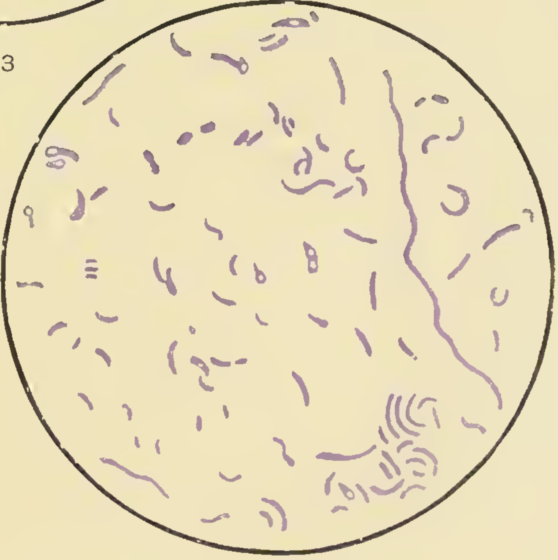

Fig. 5

Fig. 1.—Diphtheria bacillus (typical form)
Fig. 2.—Bacillus tuberculosis, in a pure culture
Fig. 3.—Diplococcus pneumoniæ (capsulated condition)
Fig. 4.—Streptococcus pyogenes
Fig. 5.—Spirillum of Asiatic cholera ("Comma bacillus")

(*From "The Medical Annual," 1899*)

either division or sporulation is going on. This, and the differences that mark the various stages of their life or are consequent on deterioration, add to the difficulties investigators meet with in their work of identifying such minute forms as the bacteria and others.

First Revelations and Later Discoveries Concerning Microbes.

Before the invention of the microscope in the seventeenth century, no definite knowledge, such as we now possess, concerning the minute forms of life was obtainable; neither were convincing proofs as to their origin attainable, nor consequently of the truth of the now generally accepted germ theory, namely, that "all living things, however small, come from living parents." It is true that there arose from time to time, more especially after good progress in natural history and physiology had been made, learned thinkers of various nationalities, who, guided by the deductions they shrewdly drew from established facts, arrived at approximately true conclusions as to the properties common to all organic bodies and as to their generation or birth. Such thinkers and their followers were little disposed to admit the truth of the long and widely credited theory of "Spontaneous Generation," that is, "life out of nothing," around which controversy raged century after century, now waning, now gathering fresh interest. For instance, believers in spontaneous generation hailed with the greatest satisfaction the revelations of the first, and very imperfect, microscopes, as powerful evidence in support of their theory, "for had not the microscope revealed the existence in the air and in rain-water of many myriads of infinitely small creatures capable of increasing by the million in less than forty-eight hours? How otherwise could their creation be accounted for?"

Alas for their convictions, founded as they were on imperfect knowledge of facts! For ere many generations had passed, more powerful and more adjustable microscopes and better methods of work enabled investigators to watch the very act of microbe reproduction. With many microbes this results by the simple act of self-division, but in others after a more elaborate fashion, or by the less self-suppressing system of throwing off gonidia and buds. There could no longer be any doubt as to how the reproduction of micro-organisms occurred, any more than about the birth of higher plants or animals. But where multiplication is brought about, as in many of the one-celled microbes, by self-division, or as it is called by fission, a problem suggests itself that perhaps you might like to try and solve. Given A, a parent microbe, which when full grown has divided into two, B and C, what has become of A ? We cannot say A is dead, for where is the corpse ? nor reckon B and C as dead either when they in their turn a few minutes later divide into D and E and F and G.

Amazing indeed is the rate at which multiplication goes on in some thriving bacteria—up to seventeen millions from one individual per hour, and it is no unusual thing in cultures of a less prolific kind to witness the rise of forty-eight generations in twenty-four hours, as against three generations of man in one hundred years. Fortunately, as experiments in culture show, antiseptics of a strength harmless to man will at least arrest multiplication, thereby preventing increase of the infecting agent.

The theory of "spontaneous generation," notwithstanding its having suffered so complete an overthrow, dies hard, for even now, in our twentieth century, it is not entirely without supporters or at least not without believers in a modified form of it. Yet surely, though marvellous delusions now and again obtain credence, never in this matter will the world hear of anything so grossly absurd as the celebrated prescription of a learned Dutchman of the seventeenth century, Van Helmont, who is credited with having taught that "it is quite easy to work the prodigy of creating mice, by putting some dirty linen in a receptacle together with some crumbs of cheese" !

Fortunately for the credit of human intelligence, somewhat later two Italians demonstrated by simple experiments, the one that worms in rotten meat do not appear spontaneously, and the other, that a grub inside a fruit is hatched from an insect's egg laid before the fruit developed.

In the last century, of the many strenuous workers throughout the civilized world, Pasteur did the most to advance and to popularize research into the world of "the infinitely small." He worked not merely as a scientist and experimentalist, but above all as a practical teacher, for besides demonstrating how many fermentations, pernicious or valuable, are originated by micro-organisms, he pointed out in detail the advantages to be gained from the knowledge of this fact. Again, besides teaching that all contagious diseases are due to the action of microbes, he showed his countrymen how to bring about immunity against some at least of these diseases. The system he adopted suggests the homœopathic doctrine of "like curing like," or, to put it more vulgarly, of cure by "a hair of the dog that bit you," for indeed this proverb might be taken literally as a description of Pasteur's method of treating persons bitten by a mad dog, in order to avert hydrophobia. A bit of the spinal cord of a mad animal, after it has been dried and its poison (virus) weakened (attenuated) by its being kept, is made into an emulsion, for use in a succession of injections of gradually increased strength.

Pasteur cannot correctly be called the earliest discoverer in all the fields of labour with which his name is closely associated, for many minds were independently working up to the same conclusions, as so often happens in scientific inventions and discoveries, but undoubtedly he must rank in many respects among the greatest benefactors of mankind, while on account of his genius for turning his laboriously acquired knowledge to good uses, and the striking simplicity of his convincing experiments, he cannot fail to excite both admiration and gratitude.

PASTEUR'S EXPERIMENTS.

I think nothing can better help to the understanding of our subject than to recall such of the simplest of Pasteur's experiments as bear on it.

Early in his career, while fighting with all his might a surviving advocate of the theory of spontaneous generation, he proved, positively and negatively, that when fluids become corrupt the change is due to the action of air-carried microbes which have settled in them, and not to microbes spontaneously generated.* As a proof of this assertion, he filled sterilized phials with such corruptible fluids as broth, blood, and serum, and either sealed them hermetically by drawing out and fusing the mouths of the phials, or he plugged them closely with cotton-wool. Thanks to the fluids being thus protected against intruders from without, no changes took place. After some time had elapsed, he either broke off the fused mouths of the phials, thus admitting air; or he forced into the phials the outer and dust-soiled portions of the cotton-wool plugs, and re-closed with fresh plugs. A speedy change took place in the contents; they appeared cloudy, and finally they became putrescent. This experiment shows in the first place that the cotton-wool plugs had acted as air filters, and in the second, that externally they had been laden with microbes.†

Upon such evidence arose the practice to which I have already alluded, that of using layers of cotton-wool to protect wounds, a practice I am proud to say was adopted in our Scottish hospitals by Lord Lister, even before it had come into use in Pasteur's own country.

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* Schwann had earlier shown that if putrescible matter in hermetically closed phials was for a time heated up to boiling-point, no putrescence appeared, but it did so when air was admitted, and he recognized the close analogy between fermentation and putrefaction.

† Hoffmann antedated this use of cotton-wool as an air filter to exclude infecting air-brought bodies, but it required Pasteur's inexhaustible labour to convince naturalists and chemists of the truth of what Schwann, Hoffmann, and some others taught.

Another of Pasteur's experiments was to take filled and sealed phials up to snowy regions, and there open them. No changes took place in the corruptible contents. The explanation lies in the absence of all micro-organisms in the air of high altitudes, the temperature being too low for bacterial life. Hence the practice, often successful, of sending consumptives or patients with a consumptive tendency to live in winter in mountainous places amongst the snows, where there are no tubercle bacilli to further infect their lungs. Hence, too, the every-day use of ice to preserve meat and fish, and the success of the modern system of cold storage.

The efficacy of heat in getting rid of microbes was very practically exemplified by Pasteur when he taught perplexed beer and wine merchants how to keep their bottled beer and wine from turning sour, namely by applying great heat for a few minutes—a process known as Pasteurizing. He also, after a very picturesque fashion, proved that the fermentation which turns grape juice into wine is caused by a tiny species of the yeast plant. This he did by covering in a certain number of vine plants in his vineyard with glass, and wrapping their bunches of grapes in cotton-wool. The grapes so treated were rather longer in ripening than the rest, and when their juice was pressed out in the wine-press no fermentation took place, as it did with those grown and ripened in the open air. The latter brought with them into the press, on their skins and stalks, the agents of fermentation, whereas the former had none to bring.

A careful doctor will advise a patient suffering from intestinal delicacy, never to put uncooked fruit into his mouth without first removing the skin, and will also caution him to limit himself to eggs, when he cannot be sure how food offered has been treated, in order to avoid any chance of swallowing some harmful microbe.

I must leave to another lecture the account of Pasteur's triumphant discovery of how to confer immunity first against splenic fever or anthrax, and later against other microbe-bred diseases. I will then also speak, as bearing on immunity, of the protective and defensive agents with which our bodies are provided; and of the composition, usefulness, harmlessness, conditional harmlessness, and hurtfulness of various microbes.

In closing, I would remind you of the high rôle which cotton-wool plays in man's battle with the microbes, and ask you to respect it as a semi-sacred thing, never to be left uncovered or allowed to fall on the ground. Should such an act of desecration occur at your hands, pray give that bit honourable cremation, rather than run the risk of its being used for dressings unawares by other hands and so possibly—oh, horror! — turned into a microbe importer.

SUBJECT VII continued.—LECTURE 2

PASTEUR'S DISCOVERIES AND VACCINES—IMMUNITY.

In my last lecture I said a great deal about Pasteur's experiments and inventions, for I thought it the pleasantest and most direct way of conveying to you the information I wish to impart concerning micro-organisms. We reached the stage in his career when he gave himself heart and soul to discovering how to confer immunity, that is, resistance or non-susceptibility to infectious diseases.

The first notable disease to occupy his attention * was splenic fever, or anthrax, which in France at that time was a perfect scourge, carrying off cattle and sheep by the thousand. Pasteur must have been somewhat helped in his researches by the fact that the bacillus of anthrax had already been identified, in 1863, by Devaine, and its identification made further certain by Koch, who isolated and made cultures from the bacillus, which in the animals inoculated therewith produced true and fatal anthrax; and also by the already accepted practice of vaccination against smallpox, or in other words, inoculation with the weaker virus of cowpox—passed through a calf—to confer immunity against the kindred, but stronger, virus of smallpox. Not that Jenner,† or later investigators identified any particular micro-organism as the one concerned either in cowpox or smallpox, but the principle involved in Jenner's vaccination is the same as in the use of the vaccines of attenuated bacterial virus introduced by Pasteur. Further, besides these two promising leads, Pasteur had another in the fairly well-founded belief that one attack of anthrax protected from a second, for did not immunity thus acquired suggest the possibility of an artificially-created immunity? After endless tests and experiments, and the sacrifice of many oxen and sheep, Pasteur finally satisfied himself and convinced his countrymen that in cultures of the anthrax bacillus he really had found a powerful vaccine, the strength of which he could attenuate and graduate at will according to the number of days the cultures were grown in a temperature of 42–43° C., equivalent to 108–109° F. For first injections, cultures grown for twenty-four days were used; for the second, those of a twelve days' growth, and finally injections which to unprotected animals would inevitably prove fatal, could be given with impunity. The stronger the virus the longer immunity held good.

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* See Réné Vallèry Radel's "Life of Pasteur."

† True or not, there is a popularly believed story that Jenner first conceived the idea that the matter from the pustules of cowpox might advantageously be substituted for that of smallpox, from the remark of a country girl to him at the time of a great epidemic of smallpox, that she was safe not to fall a victim to it, for she "had caught cowpox from milking the cows."

I have already touched on Pasteur's brilliant discovery of how to save persons bitten by mad animals from the horrors of hydrophobia, but before I leave the story of defeated infections and neutralized poisons, I should like to mention another striking example of victory, gained, as before, through identification of the infecting agent and its conversion into an antidote to its own poison. I refer to the well-known modern treatment of diphtheria by antitoxin injections, a treatment which has greatly lowered the death-rate from this disease.

This antitoxic serum is gained by repeatedly injecting a horse in the shoulder with filtrates of cultures of the diphtheria bacillus—not, as for anthrax, with the living half-devitalized bacilli themselves. Subsequently, under aseptic conditions, a considerable quantity of blood is drawn from a vein in the neck of the horse and collected in sterilized phials, in which it is left to separate out into clot and serum. The serum is then ready for use, but in bottling for exportation, a little weak antiseptic is usually added to prevent any possible decomposition. Success or failure with this serum depends chiefly on its being injected sufficiently early in the course of the disease, and on its not having been kept too long or having in any way lost its properties.

Immunity.

Such marvellous feats in combating infections and poisons seem little short of miraculous, and it is difficult to find an explanation of how the agents employed work. But little less difficult is it to understand natural immunity, what the conditions are that create it, and what those that permit of susceptibility to infection. Why, in some instances do both man and certain animals alike succumb to infections, while in others only members of the one class and not of the other? Or why in individuals does resistance hold good against some diseases and not against others? And lastly, how come there to be differences in power of resistance in members of one family?

Explanation in part is offered by the well-known fact that we are provided with defending agents in the white corpuscles, or leucocytes, of the blood, in other wandering leucocytes, and in a certain class of tissue cells, all of which have the power to take up bacteria into themselves—hence the name of "phagocytes," or "devourers." Besides these, late writers tell us they think we possess other protecting agents in certain antitoxic substances ("complements") which lie stored in us, capable of chemically neutralizing introduced poisons, the advent of which excites their activities and stimulates their fuller development. This theory finds support in the fact that bile and the normal serum of horses and certain other animals if injected into various animals, afford proof of possessing antitoxic, or immunity-giving, properties. Hence, possibly, the serum of a horse used in the making of an antidiphtheritic serum may in itself count for something in the saving properties of that serum, and if so, sufferers who benefit by its use should not only sympathize with the poor animal in his discomforts on their behalf, but also be grateful to him for bestowing on them a saving something of his own.

Most of us realize how persons in poor health or with low vitality more readily fall victims to infections, and are less likely to recover, than stronger persons. Clearly in these weak folk their defending garrison is not of sufficient strength, or its soldiers do not make a good fight, and this because they are being poorly or wrongly fed, for they—the phagocytes—are but cells, and every cell in our body, whatever its class or office, must have its vitalizing protoplasm rightly and sufficiently fed if it is to do its work properly. Pasteur once gave striking proof of how a lowered vitality lends itself to infection, for having failed to infect a fowl by an injection of his fowl-cholera culture, he immersed the bird for a considerable time in cold water, after which the vaccine quickly took effect.

Lastly, may not inquiries into the causes which lead to the termination of and recovery from infectious maladies, result in light being thrown on the subject of immunity? Might they not possibly be the same as those which create immunity, whether inborn or naturally or artificially acquired? It would be interesting, too, to find out at what period in the course of a contagious disease they begin to tell. For instance, what is it in the crisis of favourable cases of pneumonia that causes its characteristic sudden and great, but safe, fall in temperature? When this happens, what occurs as regards the infecting agents?

Still, in spite of such leads, the puzzles that natural inborn immunity present remain, and are at best but suggestively explained, for although man now knows to a certain extent how to bring about artificially-induced immunity against some diseases, even this latest advance lacks the complete explanation which nevertheless we believe cannot be far to seek. For the present, and till fresh discoveries reward investigators, we have to rest contented with the advance made.

DIFFERENCES BETWEEN SAPROPHYTIC, PATHOGENIC, AND CONDITIONALLY SAPROPHYTIC BACTERIA.

Because so much attention is paid to pathogenic bacteria you must not suppose that they constitute anything like a majority amongst bacteria. On the contrary, by far the greater proportion consists of saprophytes, as opposed to pathogenic parasites. These are harmless, and many of them are highly useful to mankind, for living as they do on dead vegetable and animal matter, they perform the work of scavengers, while some act as enrichers of the soils out of which they draw their nourishment. One set known as " nitrifying bacteria " more especially benefit the soil. This they do by assimilating the nitrogen of the air (a power they possess as plants), and nitrogen combining with ammonia—that final outcome of putrefaction—fertilizing nitrites are produced ; or they more generally arrive at the same result by a curious sort of co-operative process, when living in nodules on the roots of plants of the pea order, a fact known and appreciated by large growers of beans and tares. Recently bacteria have been made to turn their powers to account for the purifying of town sewage, while others, in less unsavoury surroundings, work to ripen cheese or to render flax-stems fit for use.

Between harmless saprophytes and disease-producing parasites, there is a class which might be described as " conditionally harmless " bacteria, that is, bacteria which can, and commonly do, live like saprophytes, even when present in animal bodies, but which, as opportunities present, are there capable of assuming quite another character. When living as saphrophytes, they do not feed on living tissues, but on the remains of food in our mouths, and above all on the dead organic matter contained in the large intestine, where, in the economy of Nature, they most probably are of use. The average number per day of our intestinal bacteria has been put at 280 billions, and in bulk they form a very considerable proportion of the fæces. On the other hand, so great a multitude, with their amazing powers of reproduction, suggests the possibility of trouble should anything, say constipation or bowel inertia, delay evacuation, for then their absorption along with intestinal fluids could hardly fail to exercise deleterious influences, which well may be the exciting cause of many an unaccountable ailment. Every General knows how camping too long or in too great numbers in one place affects adversely the health of his troops, even so may a too great accumulation of generations of intestinal bacteria, or their over-protracted occupancy, injuriously affect an individual. Moral : Constipation and bowel inertia should be combated, and preference given to thoroughly cooked food as against raw or indifferently protected cold cooked foods, as being less likely to have become contaminated.

Undoubtedly harmful prove these intestinal bacteria (*Bacillus coli communis* and others) when a bowel is perforated by abscesses or ulcers, etc., and they are thus let loose within the abdominal cavity on to its delicate lining, for in a few hours the effect of the action of these poisonous tissue-sucking micro-organisms shows itself in gangrene of the parts. With an intestinal abscess there is a fair chance of life being saved if an operation is performed before perforation takes place; and even up to six hours after this disaster has occurred, an operation and disinfection of the parts may possibly save the patient; but not after six hours, for then mortification sets in, with a quickly fatal result. If a lesion occurs in the skin, the cocci—staphylococci and streptococci—that hitherto had been living as saprophytes, will change into parasites and pus-creaters. What is more, conditional saprophytes lie under strong suspicion of being ready, when genuine pathogenic bacteria appear upon the scene, to go over to the enemy. At least colour is given to this suspicion by the well-recognized fact that several pathogenic bacteria do not excite the particular diseases of which they are the special agents unless they have the company, if not the actual co-operation, of certain ordinarily harmless bacteria.

You may perhaps be glad to hear that bacteriologists find that as generations increase in cultures, the colony begins to perish, owing to the accompanying increase of fouling of the medium in which they are living and feeding. Where pathogenic bacteria are concerned this is indeed a welcome fact, since it means that should they escape our bodily defenders—the phagocytes—they bring a cause of death with themselves also, which will sooner or later stop their multiplication and so ensure for their victim a cessation from further infection.

THE COMPOSITION OF MICROBES.

Before we part company with microbes, we would do well to enlarge our acquaintance with them by considering their structure. They are composed, as we are, of the only known living matter—protoplasm, with this difference, that in us it is present in an inconceivable number of millions of protoplasmic differentiated cells; that is, many properties and different functions are divided amongst specialized tissues and entrusted to certain organs, whereas in some micro-organisms protoplasm is contained in a single cell wherein apparently all the vital functions—assimilation of food, growth, contractility leading to movement, and reproduction—are carried on indiscriminately. This, however, is true only of quite the simplest forms of organic life, that is, those that lack the characteristic features of cell-structure, namely, a nucleus and a cell-wall or membrane. But perhaps it is that these are indistinguishable rather than wanting. Under the microscope they have the appearance of tiny jelly-like blobs of protoplasm. Of such the chromaceæ—which are to be seen in the sea or in fresh water as deposits on rocks, stones, or wood, massed together in such quantities as to produce a red, blue, orange, or violet coloured mass, as the case may be—afford a striking example. Professor Haekel* considers the chromaceæ and other like non-nucleated single-celled organisms the lowest class of bacteria included, to be representatives of the first stage of organic life in our world.

In other one-celled micro-organisms of a less primitive type, cell characteristics can be distinguished, and therefore they may be looked upon as affording the earliest example of that division of labour, or differentiation into parts, which attains its fullest development in the higher animals and in man. In yet other one-celled microbes, those that do not multiply by fission but by the more complicated process of mitosis, or indirect division, with its curious accompanying development of two spindles or a pair of polar stars, and of increasing pairs of threadloops, etc., it becomes evident that the nucleus is the part of a cell most concerned in reproduction. Again, certain thread-like bacteria afford examples of further adaptation of parts to special purposes, for their filament-like form is due to the extension of an external membrane or sheath that covers and so connects whole strings of otherwise separate cells; moreover, with these bacteria multiplication is not by division, but by the throwing off of gonidia at the outer free end of the string of cells, from which fresh individuals are formed. Sometimes this takes place at one or more divisions, or, so to speak, between the beads of the string, and at times these bacteria even revert to the primitive process of reproduction by self-division. Further, amongst the higher bacteria, the cladothrix and the leptothrix show branching, suggestive of less microscopic plants. These largely prevail in some soils, the latter producing a matted effect from the interlacing of their knotted thread-like forms.

As regards movement, some microbes, such as the amœba and the yeast plant (to take an example of an animal and of a vegetable micro-organism), though not possessed of any locomotor appendages, manage by means of their contractility to move about, while others are provided with pseudo-limbs, the so-called flagella and cilia. Even with these, few make any progress and for the most part are at the mercy of winds and currents. The well-being of micro-organisms turns largely on their reaching water, so, though some will long survive lack of water and food, their protoplasm cannot be rightly built up without them, nor consequently can that sequence of changes be completed which, alike in man and in microbe, constitutes life, namely, the building up of protoplasm by appropriate food, and its breaking down thanks to its own activities, with an accompanying expulsion of waste products. This is the obvious law binding on the whole organic world ; but less easy to follow are the laws that regulate the manifold chemical changes which go to form differently constituted and differently endowed organic bodies, not to speak of the effects of external influences—say of air, light, heat and cold, water, soil, food, environment, and limitation or non-limitation of space—on organic bodies.

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*"Tabular Survey," Professor Haekel's "History of the Creation," vol. ii, page 61, 4th edition.

All these conditions have to be considered by investigators into the composition and properties of microbes ; and before any practical results from experiments, or otherwise, can be looked for, it is necessary in pure cultures to ascertain what is required for the rearing of flourishing families of microbes. Just as gardeners have to know the soils, exposures, and temperatures best suited to different kinds of plants—a richly manured ground for roses, a peat soil, with protection from wind, for rhododendrons, damp and shady places for lilies of the valley, top dressings of lime, etc., in some cases, and varied degrees of heat for greenhouse and hothouse plants—so, too, growers of bacteria have to study the respective requirements of their subjects as regards food, temperature, air, and light. Without an abundance of thriving pure (all of one kind) colonies at command, identification of species cannot be certain, nor can knowledge be gained as to which do or do not produce spores, nor experiments be rendered conclusive as to the effects of any of the various antiseptics on the different microbes. I do not purpose speaking to you of the chemical experiments made on bacteria, which are best studied in laboratories, nor about the many antiseptics in use, leaving their advantages, disadvantages, and proper application to be set before you by your doctors and practical instructors.

Bacteria are mostly what might be called non-orthodox feeders, for their selection of food, when they have a choice, is rather that to be looked for in animal feeders. In this, their requirements differ from those of true vegetables, while parasitic bacteria, as compared with saprophytic, differ still more markedly in this respect. They demand, as a rule, a temperature of about blood-heat, and the media provided for them must contain elements such as they draw from living animal tissues. Then, in the matter of air, some bacteria cannot endure it, and are hence called anaerobic, while the rest, and by far the greatest number, are aerobic (requiring air). Thus, with harmful anaerobes, their conversion into available vaccines is greatly facilitated; for it is possible to attenuate their virus—which means partially to devitalize them—by merely exposing them to the air. Examples of anaerobes are the bacillus of tetanus and the bacillus of anthrax, and it was when experimenting with the latter that Pasteur discovered he could graduate at pleasure the virus of such vaccines by a longer or a shorter exposure to the air. Many bacteria, however, thrive equally well with or without air, but light is more or less harmful to them all, and direct continued sunshine will kill them; whence, on this score alone, the advantage of inhabiting sunny rooms.

Another distaste common to all bacteria is for acids, and apparently not without reason, for experimentalists have proved that if an acid be added to an antiseptic or to heat, the destructive effect is strengthened and hastened; also that the cholera spirillum in culture will not grow where there is any free acid. Their distaste for acids, and the effect of acids on them, perhaps explain not only why when the lactic acid bacilli have turned milk sour, the bacterial agents of putrefaction for the most part leave the milk alone, but also why bacteria so little haunt the stomach and small intestine, where acid digestive secretions prevail, as compared with their numbers in the large intestine which, like the bladder, is rather a reservoir than a place for digestive processes. Further, it is said that a sufficient quantity of our gastric juices, with their hydrochloric acid constituent, can kill the spirilla of cholera.*

The most striking characteristic of microbes, and which, in spite of individual minuteness, gives them such importance in the economy of Nature, is the extraordinarily rapid rate at which they are capable of multiplying; and hardly less important is their property of secreting and giving off various ferments. By means of these they work great changes, and also are enabled to break down chemical compounds and hard materials which otherwise could not serve them as food. Another use to which anaerobic bacteria put their ferments is to get oxygen, for though they cannot endure it free in the air, it is none the less necessary to them, and they attain their object through the action of their ferments on sugar, or any substances out of which sugar can be extracted.

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* Hydrochloric acid acts as a valuable disinfectant, inhibiting the growth of organisms, and consequently is a factor in the prevention of intestinal putrefaction. By setting up acid fermentation, the growth of intestinal flora of putrefaction can be prevented. Fermentation increases peristalsis. An important factor in pathological states is the secretion of mucus, a substance extraordinarily liable to putrefaction. Example: the foul-smelling stools of enteric disturbance.—"Intestinal Digestion," *The Hospital*, Feb. 1, 1908.

It may interest you to know that microbes secrete diastatic and peptic ferments, much as do our digestive cells, but instead of keeping them for home use, they apply them externally. Unfortunately, however satisfactory to themselves the changes in matter which they compass may be, their processes when carried out on living subjects are not always without bad results for the latter. But far more direct and injurious are the effects of the intense poisons which a few pathogenic bacteria elaborate and give off. For example, the poisons of the bacillus of tetanus, the bacillus of diphtheria, and the spirillum of cholera are said to correspond to scorpion and snake venoms, which in their turn answer chemically to two deadly vegetable poisons, abrin and ricin. These two vegetable poisons have been used successfully to render animals immune to snake-bite. So again we have an instance of what seems a case of "like curing like," though the protection may really be due to the chemical attractiveness of the introduced poison stimulating dormant antitoxic elements and so leading to such chemical changes as eventually neutralize the poison if not too powerful, and develop larger supplies of antitoxins, wherewith in future struggles to combat stronger poisons.

Such then are our invisible but no longer unknown foes. Forewarned as we now are, ought we not to keep ourselves forearmed, ready to meet foes that do not assault by day, with the shouts of daring soldiers, but stealthily and imperceptibly, and who are not incapable of poisoning our water springs and our markets? Health officers and doctors have to see to the safety of the camp, and you who work amongst microbe-wounded patients and sickly folk have to prove yourselves not somnolent sentinels, letting the enemy pass unchallenged, but ever-vigilant guarding angels.

SUBJECT VIII

INFLAMMATION

Lecture I

INFLAMMATION: ITS WORK FOR GOOD AND FOR EVIL

You are familiar with the word "inflammation" and with much that it implies, with a familiarity that is far from justifying the saying, "Familiarity breeds contempt." Though your present attitude of mind on this score is a fitting one, and though I certainly do not wish to preach contempt, I do wish to lead you to regard inflammation as not necessarily or solely an evil agent, but on the contrary one that works to overcome evil by removing irritants and repairing injuries. This is what the observers, teachers, and learned men of our century now inculcate, their teaching being founded on world-wide researches and on what experiments on animals have revealed as to the processes of inflammation. Inflammation is not a state, but consists of a series of processes, few or many and successful or unsuccessful in benefiting a patient according to the severity of the injury, the virulence of the irritant, or the health of the individual.

These exponents—the best known of whom is the eminent Russian, Metchnikoff—hold that the main factor in the reaction of inflammation is a phagocytic, or "devouring," property exercised at the expense of the invading microbes by local and wandering leucocytes (the white blood corpuscles) which, when needed for this work, pass out from within the porous walls of the capillaries, and also by a certain class of tissue cells. Equally wonderful is the work some cells accomplish in the repairing of damaged parts, through self-extension to begin with and afterwards through a vast increase in numbers. Ingested microbes (microbes enclosed within leucocytes) have been seen, not merely by a few observers but by all proficient seekers who work with microscopes; and thanks to the labours of those earlier investigators who identified many of the disease-producing micro-organisms and learnt how to maintain pure cultures, the observers of to-day are enabled to tell us the names of these imprisoned microbes. But the points which have greatly puzzled them are:

what is the signal that draws phagocytes into the fray, and why do they sometimes attack at once and at other times hold back till later? The explanation most commonly accepted is, that whereas some micro-organisms chemically attract the phagocytes, others—of the more virulent sort—chemically repel them, while once the toxins which the microbes give off become neutralized in time by the blood, unless its constituents happen to be exceptionally poor, then the phagocytes come into full action.

But this is not all: for it seems a well-established fact that the leucocytes could not conquer the invaders were they not helped in varying degrees by certain antitoxic elements which prevail in the tissues and fluids of animal bodies, and also by various groups of so-called "intermediary bodies." These all work to prepare the way for the devouring leucocytes, be they ferments exuded by living leucocytes or ferments derived from crushed and dead leucocytes contained in the serum of a wound, or quite different substances. Here in England Sir A. Wright has done much to prove how essential to the success of our defending phagocytes is the presence of certain intermediary bodies which he has christened "opsonins," that is, "caterers"; and so convincing were the proofs he brought to bear on this point, that a practical use now is made of his discovery. Other investigators speak of an adhesion-creating product by which the phagocytes entrap their victims, more than one of which may be seen at a time sticking to their ultimate devourers. Hence the descriptive term of "hedgehog-like leucocytes," and the appropriate name of "fixateurs" given by foreigners to this intermediary vehicle.

But if the phagocytes are well provided with auxiliaries, so also are the invaders, and when the microbes happen to be highly virulent ones, the tables are only too likely to be turned on the leucocytes. Close observers with powerful microscopes have been witnesses of a Jonah-like escape of ingested, but not yet digested microbes, and of how these microbes start afresh on a career of tissue poisoning and rapid self-propagation. When suddenly called upon, our defending phagocytes do not come to the work devoid of experience or practice. They are like soldiers who from daily drill or gun practice are summoned to a real field of action; for if we consider the fact that disease-producing microbes of one sort or another are nearly always to be found on the skin or on internal membranes, it would seem that we owe our general exemption from disease to the ever-present phagocytic cells and to the antitoxic and anti-microbe substances with which we may have the good luck to be well provided. On this score, however, I will not say more, lest we be landed in perplexing questions concerning natural and acquired immunity from infection. Moreover, for the present I will confine myself to external localized inflammation in flesh injuries, abscesses, and ulcers, and to the phenomena of gangrene, that highest process of inflammation.

I have little doubt that while listening to me you may at times be disposed to say, "If inflammation is a friendly agent, then save us from our friends." But as in military warfare defenders of house and home are forced at times to have recourse to self-damaging measures, so with inflammation in its wars. A patriotic General may find it necessary to sacrifice bridges in order to delay the advance of a formidable enemy, or to burn down whole woods to deprive him of shelter, or even to reduce happy dwelling-places into mere loop-holed walls. Thus with inflammation: according to the greatness of the force it has to fight and the spot in our bodily home on which the battle has to be decided, its destructive efforts are to be dreaded. Though in most parts of our bodies heat, distention, and even suppuration —the characteristic steps of inflammation—need not ultimately lead to much damage, the results may be far worse in, for instance, a smallpox pustule in an eye or an abscess in some important internal organ, for sad are the breaches those piercing and excavating proceedings create. It is true that surgeons and doctors can in some cases modify or change the direction of inflammation, while on the other hand they may be glad at times to work on the lines indicated by it.

Of all this you will have experience in surgical wards, and I would fain help you to understand what you see there.

But before I speak of the processes of inflammation, let me cite two instances to show how helpful inflammation may prove. When a fractured bone has failed to unite within the time usually required for reunion, it may be made to do so by exciting inflammation through friction, namely, by lightly rubbing the broken ends against each other, with the result that the plastic lymph, on which union is built up, is thrown out. This lymph is composed of serum, fresh loops of capillaries, and white blood corpuscles, interspersed with some bone-germs, and is distinctly a product of inflammation.

The second example of salutary inflammation is often seen in favourable cases of croupous pneumonia. When the lung-consolidating stage has passed, it is with satisfaction rather than anxiety that a doctor views a fairly high temperature, for the reaction of inflammation is needed to liquefy the consolidating exudate produced by the disease, and so enable choked air-cells, blood-vessels, and bronchi to resume their respective work, and allow of mucus being got rid of through the relieved bronchi, for though much depends on the virulence or non-virulence of an infecting pneumonia, it is generally held nowadays, that a pneumonia patient with a somewhat high temperature has a better chance of recovery than one with only a slightly raised temperature.

The long-accepted definition of inflammation—I had almost said its classical definition, because medical students are familiar with it in Latin—runs thus: Redness, swelling, heat, pain, and possibly impaired function. This definition, or rather the list of characteristic symptoms, can only be appropriate in full when inflammation is extensive, externally visible, and situated in a loose-textured part of the body well supplied with blood. Under other conditions it is scarcely so, for example when the only indications of its presence are a little locally perceptible heat, and a feeling of slight uneasiness. Let us, however, see for what these descriptive terms stand, for your acquaintance with them and their meaning will help you to understand the different stages of the process of inflammation.

Redness indicates a local distension of the blood-vessels, not recognizable in internal parts, as in pericarditis, enteritis, and meningitis, but obvious enough in sore throats, sore eyes, and some forms of gout.

Swelling may indicate either distending serum or lymph, resulting from an overcrowded state of local blood-vessels, as in congestions, or the presence of pus.

Pain, where connected with inflammation, may be due to irritation of some terminal nerves, or to the pressure which the swelling creates, and it is then severe in proportion to the unyielding capacity of the part affected. Hence the great pain of toothache and of a whitlow largely covered by the nail.

Impaired function may be caused, over and above the evil effects which infecting microbes produce in a wound, through inflammation so changing the tissues of the injured part that it ultimately becomes more or less disabled, as well as disfigured; for exuded serum, if not absorbed or carried off, will either decompose or organize into less elastic tissues, muscular tissues being replaced by fibrous and epithelium by connective tissue. These replacing and contracting tissues will sooner or later bring healing, but not of the best sort. This is a point I wish you to bear in mind, not only because it explains why some healed wounds and abscesses present a puckered and disfiguring appearance, but because such a result is surely an additional reason why all known means should be employed and every care taken to ensure that nothing happens that would interfere with that non-disfiguring and non-disabling type of healing known as "healing by first intention," about which I will speak to you in my next lecture.

Neither this much-to-be-desired "healing by first intention," nor aught else that is good, is to be looked for in a microbe-infected wound, and so common and serious is this risk that though to-day I am not speaking about bacteriology, I cannot forego this opportunity of impressing on you how real are the invisible foes we call microbes, and how great is their power to destroy our tissues or poison our whole body. We can scarcely wonder that the uneducated poor have little, if any, belief in their reality, seeing how often their children, and working-men, with cuts and wounds, escape further trouble. If the suppurative stage is reached, it is looked upon as a matter of course, and should there be disablement, there is always the hospital to go to and compensation from the employer in proportion to the time of disablement. In vain one implores a mother in whose cottage cats and dogs, cocks and hens, pass out and in at will, and at whose door is a nasty gutter of which she makes free use, to see that her little Molly's cut hand is tied up to prevent her using it and thus loosening a protecting antiseptic dressing. Alas! by next day the dressing is more than half off, and shows signs of having been dirtily wetted. Still, the cut is well-nigh healed, and it is idle to talk about microbes. Let us hope that the next generation, thanks to the hygiene and physiology now taught in our elementary schools, may acquire a holy horror of microbes, though anyone who thinks that a child will ever forego plunging a cut hand into a dirty pond or a filthy open gutter wherein floats some coveted object, must be singularly sanguine.

Though I hope you believe in the reality of microbes, I would like to enlarge your knowledge of their powers for mischief in open wounds; therefore, instead of speaking of them indiscriminately, I will direct your attention to two sets of truly formidable pathological ones—the chief producers of pus. They are members of a class of bacteria known as the cocci, and to these particular two have been given the names of "Staphylococci" and "Streptococci," names that cover many varieties, representatives of which I have little doubt are present, though unknown to you, on your hands and above all under your nails. As long as the skin is unbroken these cocci do no harm, but woe betide a cut hand or an operated limb if they gain access to the unprotected flesh. You perhaps wonder how such minute invaders, with neither the tearing tooth of a mad dog nor the fang of a snake, have the power to poison us or to destroy our tissues. The astounding rapidity at which microbes multiply is the main cause of this great power. Some propagate at the amazing rate of between fifteen to twenty millions per hour, but what enables these particular cocci to break down and dissolve animal tissues is the strongly peptonizing ferment they possess, which acts on living animal tissues in the way the peptones which our gastric juices contain act on a piece of swallowed beef, reducing it to pulp.

As to their poisoning influences, they result in the first place from some of their products being absorbed, and later from the accumulation of dead microbes and leucocytes (dead invaders and defenders) within a small space; for seeing how rapidly microbes multiply and how incapable most of them are of changing their quarters, they must inevitably soon exhaust and foul their pasture ground. Hence their power of rapid multiplication brings with it their own death, but not before the space in question has been turned into an overcrowded and underdrained camp, and finally into a corpse-covered battlefield.

Though both these long-named cocci are pus-producers, they differ considerably in their ways as well as in their appearance. The staphylococci usually move little, and therefore are only locally destructive, unless having gained access by chance into a blood-vessel they there get so entangled in capillary fibres and coagulating blood as to become part of an embolus and as such are transported by the blood, carrying infection to wherever the embolus impacts. The streptococci, on the contrary, owing to their preference for lymph spaces and vessels, more often find means of moving, and hence of working harm far as well as near.

A more striking object-lesson on what these cocci can do could scarcely be found than a case which lately came to my knowledge. Its wretched subject was a half-witted lad, brought into hospital with an enormously swollen foot and ankle that demanded an immediate and very extensive operation. Two days later it became necessary to make large incisions in the left hip, and so rapidly did the invading evil advance, that within ten days five operations, including amputation of the foot, were performed. The lad could throw no light on the origin of his condition; there was no wound, nor any trace of a wound, and no sign of an infecting embolus having impacted internally. But on the left hip there was a mark, scarcely to be called a scratch, no bigger than the head of a good-sized pin. This the operating surgeon, rightly or wrongly, considered the point of entrance of the infecting agent. In cases like this, often the original focus of infection cannot be discovered, a fact that makes one realize more and more how formidable are our invisible and silently working foes. Mercifully, however, we are not altogether powerless against them if we are unfailing in our vigilance and make good use of the weapons of defence with which research and experience have supplied us.

When doctors or writers in treating of inflammation speak of its ordinary early stages, they mean the three following conditions: (1) *Congestion*, or a too great determination of blood to some one part of the body; followed by (2) *Stasis*, a delayed circulation of the blood, with a consequent overcrowded state of the blood-vessels of the part affected; and, if the said condition holds, then (3) *Effusions* of plasma, serum, and leucocytes into the tissues through the distended walls of the capillaries. If these effusions are absorbed or carried off by the lymphatics all will be well, but if not, suppuration will probably result before long from the presence of pus-creating microbes, or of a chemical irritant, or of some foreign body within the tissues, which, aided by inflammation, they are striving to throw out, and then begins the war between invaders and defenders, with much loss of life on both sides. But do not suppose that these typical divisions always hold good, for the shape and position of the part concerned or the character of the tissues on which the inflammation acts may make a difference even in the early stages of an inflammatory process, and so also may the degrees of inflammation required to either bring about repair or cast out irritants, while the visible effects of inflammation may be still more varied according to the amount of suppuration present.

The Healing of Wounds.

A non-professional person might very possibly be surprised to hear that of all serious wounds those made by an operating surgeon's knife are the most likely to heal well and rapidly, provided the part operated on was free from pus and that the skin had been previously unbroken. I ought to add, provided that sufficient antiseptic means had been taken; for in most favourably placed cases "healing by first intention" mainly depends on this last condition. This term is a good one, for it well expresses what happens, namely, that there has been no breakdown nor arrested and recommenced healing, and hence no change of tissues, with a consequent disfiguring cicatrix. One reason why surgically-made wounds heal readily and inflammation does not progress beyond its three primary stages is that the injury to tissue by a skilfully directed sharp knife is small. Apart from severed blood-vessels, in some cases little more than a few minute layers of cells are sacrificed, and as to resulting exudates—serum, leucocytes, plasmic cells, and lymph—they are not unmitigated evils, if in the main they are removed, either from the first by pressure, or by drainage. For once the blood-vessels are ligatured and the edges of the wound accurately brought together by stitches, the serum, or rather what remains of it, acts as a cement, while leucocytes and plasma cells infiltrate into the lymph, which under healthy conditions should organize into the fibrous tissues that make for true union. Over the line of incision some light antiseptic or aseptic (boiled) material is laid, and on to that masses of salicylic or other wools are firmly bandaged. Unless a rise of temperature suggests trouble, the wound may then be left untouched for perhaps a week, by which time it will have healed perfectly.

Nowadays many surgeons, once the sterilizing measures preparatory to operation have been carried out, and if circumstances permit, make no further use of chemical antiseptics, but rely on the aseptic condition of the area of operation and of all that comes into contact with the wound. They hope thus to give it a better chance of healing rapidly than it would have if irritated by antiseptic applications, which are not much more favourable to an open wound than to the micro-organisms against which we employ them.

In principle, the preliminary antiseptic measures preparatory to operation are the same everywhere, but in detail they vary considerably, not only in different countries but even throughout a country. In Germany the precautions are more elaborate than with us, whereas in France they seem simpler and certainly more economical. For example, I have seen a French surgeon about to perform a delicate operation, provide himself with nothing beyond two standard antiseptic lotions, carbolic acid and corrosive sublimate, and render his instruments aseptic by no more lengthy or expensive a process than passing them through the flame of some spirit alight in a small bowl. In the house of a poor family, a French doctor will content himself with an old piece of linen well boiled in a covered saucepan as a medium for a boracic dressing, while in the humblest artisan's house he probably would find both carbolic acid and boracic lotions, for the French of all classes early learnt the value of these antiseptics, thanks perhaps to their just pride in Pasteur's discoveries.

I will not speak in detail of the measures taken preparatory to an operation, leaving you to learn by observation; but I would like to set before you the aim of these measures, the difficulties which have to be overcome, and the grave responsibility that rests on those whose duty it is to carry them out, for in this matter a simple thoughtless act or oversight may undo what much care and trouble had effected. The aim and object of all measures is to prevent any infecting microbes reaching the flesh laid bare and unprotected by the knife. Infecting microbes may reach it from a patient's own skin, from the hands of surgeons, assistants, or nurses, or from the instruments and dressings used. To render a patient's skin aseptic is not a simple procedure, seeing that neither of the only two infallible microbe-destroying agents—cold down to or below freezing-point and heat up to or above boiling-point—can be applied. But much can be done to damage or remove the infecting enemy by a succession of cleansings and by antiseptic processes. Fortunately, the discovery of the power of iodine has provided our surgeons with what considerably curtails these lengthy proceedings.

Whenever iodine is to be the local disinfectant, on the morning of her patient's operation, a nurse should on no account wet the part on which the surgeon's knife is to operate, for as water soddens and for a time swells superficial skin cells, it would thus prevent the iodine from penetrating into the lower ones. The two difficulties that have to be overcome as regards the patient's skin in the area of operation are, the removal of all hair under and round which microbes might lodge, and of the natural oil which would prevent chemical antiseptics from taking full effect—from biting well, as it were. For the former, the razor is required, and for the latter an abundant and oft-repeated use of soap and spirits—maybe ether or turpentine. After this, the part is carefully protected either by an antiseptic or aseptic dressing, till the patient is handed over to the surgeon. Now, supposing this dressing were only an aseptic one, and that a nurse touched it with her uncleansed hands, might she not be the means of introducing the much-dreaded microbe? If she were not, it would be rather by good luck than good care!

Accident-Caused Wounds, and Abscesses.

Very different from what I have been describing is the condition of bad accident wounds, with much tearing of the flesh, and which have not been immediately attended to. Different too is the initial treatment of such wounds by the receiving surgeons, in order to counteract the advantage which infecting organisms have gained from delayed treatment. These infecting organisms may have come of the soiled garments of the victim or other fouling matter, while the mangled tissues have provided a pasture well suited to them and conducive to their rapid multiplication. One might not inappropriately compare their advantageous situation to that of small hothouse plants for which, in order to secure the ready growth of their tender rootlets, a gardener, before planting them out, has carefully broken up and watered the soil which is to receive them. In the wounds in question a serum exudate serves as water—an element essential to the well-being of micro-organisms.

In these cases there is none of the delicate handling by which an experienced surgeon seeks to avoid needless injury to the tissues he has just severed; but on the contrary an unsparing cleansing of every part of the wound, and if necessary the opening up of half-covered corners. After this, pure carbolic acid may be applied throughout, which process may have to be repeated before the only possible healing—healing by granulation—can be looked for. Should so strong a measure as pure carbolic acid not be advisable, iodoform is possibly substituted, or the wound may be packed with antiseptic gauze (to be frequently changed), and a drainage tube introduced. More or less similar treatment would be bestowed, position permitting, on deeply seated abscesses which do not admit of being shelled out, and where pus is thought to lie in the recesses of the path along which the abscess burrowed before it pointed and broke, or was opened. In wounds thus infected and in all abscesses, you have examples of those battles of the tissues which I have tried to picture to you, in which so far the tissues might be said to have had the worst of it, seeing that pus mainly consists of masses of dead leucocytes, of cocci and of the tissues which the latter have liquefied, suspended in escaping exudates of sorts. It is amongst inflammation's fervid work of repairing injuries that a temporary new tissue, embryonic in character, is forced out, which as it extends goes to form those uneven granulation layers on which, and replacing which, permanent connective and other true tissues arise, and to give the wound its final protecting covering.

If at the time of accidents, parts of the area of the flesh wound escape unhurt, and escape too all the ravages of the prevailing pathogenic microbes, these might serve as piers on which fresh marginal capillaries could catch, thus hastening healing. But when all such conditions are lacking and the wound is very extensive, then, as for large burns, recourse is often had to "skin-grafting." The process of skin-grafting implies cutting off strips or small patches of skin either from another part of the patient's body or from the body of some self-denying volunteer, and applying them to the wound. But the process will only be successful if the granulations of the wound promise well and there are signs of healing at the edges. You will find skin-grafting very interesting, especially when you can watch the small grafts which you saw laid on at slight distances apart, grow and spread till they meet, which they will do unless the separating distances have been too great. Successful skin-grafting tends to diminish contractions as well as to hasten healing.

SUBJECT VIII continued.—LECTURE 2

THE HIGHEST EXPRESSION OF INFLAMMATION SEEN IN ULCERS AND GANGRENE

IN ulcers and in gangrene the highest expression of the inflammatory process is to be seen, for in both there is actual loss of substance, which neither with suppurating wounds nor with abscesses need ultimately be the case. In ulcers, loss of substance takes place by what is called "molecular death," that is, death through a series of detachments of particles in themselves so small as to be invisible to the naked eye, while in gangrene (mortification) there may be detachments of by no means invisible fragments, either by sloughing, or in the more tangible form of shreds, up to the loss of a limb.

Ulcers further differ from abscesses in that they are more shallow, at least at first; that they form on the skin or on the membranous surface of deeper parts; and that they heal with difficulty. Indeed an ulcer has been described as "a break of the skin or mucous membrane that does not heal" (see "Treatment of Wounds, Ulcers, and Abscesses," by Sir W. Watson Cheyne), a description that undoubtedly holds good with some of the worst kinds, and too often also with others that remain unhealed because the sufferers will not carry out that essential treatment—complete rest of the part affected, generally a lower limb.

As there are many varieties, I cannot describe them all, but as you will certainly see many of these common and most tedious affections, I will tell you something as to the conditions which lead to external ulcers, and will explain to you, what as nurses concerns you most, why some conditions should stand in the way of their healing. The majority do not start as ulcers, but develop out of existing sores, generally in the lower extremities, the commonest cause being that a person with a sore on the leg continues to walk about or stand. Another cause of sore-induced ulcers is increased inflammation, due to the sore having become septic, or hurt by knocks or constant friction, or irritated by chemical dressings. Further, the presence of varicose veins or any condition that interferes with the circulation of the blood through the part concerned, will have a like effect. The bedsores of paralysed persons tend to develop into ulcers from lack of innervation, and possibly too from blood stagnation caused by a pressure of which the sufferers are not conscious, but which it should be the office of a nurse to prevent.

Ulcers which do not originate in existing sores, or at least not always, are the ulcers of diabetic patients, the "perforating ulcers" in the feet of sufferers from locomotor ataxy, and a larger class which tell of infecting diseases, such as tuberculous and syphilitic ulcers.

As to the conditions which prevent or delay healing in ulcers which have developed out of sores, some are the same as their exciting causes, others result from position, constitutional peculiarities, exhausted power, over- or under-feeding, or perhaps from the nature of the treatment employed by the sufferers themselves. For example, an ulcer the seat of which is on a bone is little likely to heal; nor one on a muscle, because the movements of the muscle excite inflammation; and one which in a young person would heal readily, fails to do so in an old person, while with some ulcers, their size makes healing difficult, because the new connective tissue does not suffice to cover from border to centre, whilst oft-repeated attempts at contraction serve to irritate. With such as these, skin-grafting may help, unless there be some counteracting agent.

Of some non-healing ulcers you will hear it said that they do not heal from "lack of action," and of others as not healing from "over action." I have little doubt you have already seen examples of the former class, in what are known as "weak" ulcers, very common in poor ill-fed women, especially in laundresses. Because weak ulcers are seldom sensitive, little attention is paid to them, and consequently they get knocked about till they become too serious an inconvenience to be disregarded. The edges of weak ulcers are dropsical and overhang their central surface, and sometimes the secreted water hardens. For such the essential treatment is complete rest, coupled with good feeding, while stimulating lotions and the use of a compressing and supporting rubber bandage will help towards a possible permanent healing.

Of quite a different type amongst non-healing ulcers are those known as "callous" ulcers, from their peculiarly hard and craggy edges. These are difficult to treat because they usually have been neglected They are dangerous as possible infecting agents owing to the fetid nature of their discharges and the semi-decomposed condition which often prevails in their fencing ring. The primary object of treatment is to get them cleansed and made sweet, and then, if complete rest and the improved circulation which rest should bring fail, to break down their unhealthy raised edges. Blistering, or scraping the edges with a sharp scoop, are means employed to secure this result, for so long as the bad condition of the edges obtains, no repairing capillary loops or new connective tissue can form. Troublesome and serious evils as these ulcers are when neglected, more serious by far are some ulcers of the opposite class—those which do not heal owing to excess of action. Such are "sloughing sores," the chief characteristic of which is the rapid rate at which they spread, even to encircling a limb completely, and thus necessitating amputation. The obstacle to recovery does not lie in over-hard edges as in callous ulcers, but in the absence in part, if not altogether, of a surrounding protecting border, that admits of the advance of invading microbes. This explains the enlargement of the ulcer, and its further contamination by its own secretions, till it becomes gangrenous, as the appearance of its surface will show. The only possible explanation of so disastrous a termination is that some highly virulent septic matter has been allowed to infect the original sore.

On the other hand, what prevents ulcerated varicose veins from healing is neither lack nor excess of action, but the poor provision which the walls of a vein afford to repairing tissues. I will not say more about varicose veins, for I discussed them when speaking to you of the diseases of blood-vessels.

Wearisome alike for patients and their attending surgeons as must be the constant fluctuations in long-existing ulcers, to you they afford a most valuable field in which to study the alterations that take place in losing or gaining tissues; and as ability to distinguish between a healthy and a morbid state of a wound or sore, etc., is very necessary in nurses, I strongly urge you to give your best attention to all the ulcers that come your way. Notice the character of the granulations: whether they are pale and dropsical looking, or overabundant and red—a condition popularly called "proud flesh"; whether the whole ulcer becomes black or brown, as do neglected callous ulcers; whether the edges and the centre are on a level, as in healthy healing ulcers. Then, as you become better acquainted with the various kinds and the different stages of ulcers—promising or unpromising—test the correctness of the opinion you had formed as to an ulcer's condition by the lotions or applications ordered. To make this possible, however, you must be acquainted with the various lotions commonly employed, know of what they consist, and the results to be looked for from their use. But such knowledge is as nothing compared with your maintaining a sufficient respect for ulcers and a proper dread of the harm that may come of them, and not like a certain nurse whom I heard say contemptuously, when speaking of the cases she had recently had, "Only some ulcers," for an ulcer may end as badly as a larger wound if with either there is negligence as regards dressings or the hands that apply them.

GANGRENE.

The two distinctive types of gangrene are: (1) *Moist and rapid* and (2) *Dry or chronic*; but gangrene is not always exclusively one or the other.

1. *Moist gangrene* is by far the more dangerous, especially when it assumes its rapidly spreading type, the one most likely to prevail when some crushing accident that ruptured important blood-vessels, both veins and arteries, has been the cause, for then the internal surrounding soft tissues are flooded with blood that no vessels carry off. In such cases, the changes that take place are startling—pain giving place to insensibility of the part, and redness to a livid green or black discoloration, while blebs (little blisters) appear on the surface, where they work towards the separation of the skin from the cuticle. When moist gangrene spreads rapidly, immediate and extensive amputation becomes necessary to save life, that is, amputation well above the tale-telling discoloration or any other sign of gangrene. In less desperate cases, however, when inflammation and discoloration have ceased to spread, a surgeon can afford to wait the appearance of that well-known line of demarcation which serves to mark on a gangrened limb the division between sound and dead parts, and with this line to guide him he may venture to spare more of the limb than without it he would have dared.

2. In *dry gangrene*, Nature may often be left with advantage to act the part of the surgeon, and so thoroughly does she work that nothing may remain for the knife but to sever some tendon or bone that has resisted Nature's efforts—those of reactionary inflammation in the shape of a chain of dissecting ulcers which eat away the edges of the sound part, thus producing a separating groove between it and the dead portion.

Whatever the particular cause of gangrene, it is primarily always the result of interrupted or arrested circulation of the blood, whether by reason of such an accident as I have described; or as following on frost-bites or the sudden blocking by a clot or embolus of some main vein or artery; or, as often happens in the aged, because of the hardened and closed state of a number of terminal blood-vessels that no longer carry life-giving nutrition to the extremity concerned. Besides these causes, there are two conditions very conducive to it, for which a nurse might be held answerable if it occurred in her patient, namely, an over-tight bandage unnoticed and therefore unreported by the nurse, and bedsores consequent on over-pressure. I am sure you would not like such results to lie at your door, so let me warn you in bandaged fracture cases always to be on the look out for blebs or discoloration on the uncovered fingertips or toes, and with paralytic patients to be at great pains by a frequently changed position to ward off pressure and consequent blood stasis, seeing that such patients are not conscious of pressure. Further, cases of chronic dry gangrene in old persons such as are usually left to the care of a nurse, involve grave responsibility. The instructions usually given to the nurse are to avoid all sudden changes from heat to cold for the gangrenous part, be it a finger or a toe, and to keep it thoroughly dry; if need be, to separate the toes with a piece of dry antiseptic material—boracic lint is the simplest and best. Nowadays, though gangrene always means danger, it is not always fatal, thanks to improved modern treatment, so that persons with senile gangrene may long survive, in spite of losing a toe or even a foot. But scientific treatment will fail if a nurse is not exact and very careful.

I have on purpose made no mention of the feverish state which so often accompanies the forming of an abscess, or, as frequently it does, the healing of wounds, even such as heal well from the first; neither when speaking of ulcers have I alluded to that most troublesome type — gastric ulcers. To have done so would have added to my already too extensive subject, "Inflammation acting externally."

SUBJECT IX

PARALYSIS

LECTURE I

THE NERVOUS SYSTEM—MOTOR AND SENSORY NERVES—THE BRAIN AND THE SPINAL CORD

THE course of our studies has brought us to the consideration of the nervous system—that great central governing system of the body by which our thoughts, sensations, and movements, voluntary or involuntary, and all the metabolic processes of our ever-changing bodies, are vitalized and regulated.

In one short lecture it is impossible to give you more than a very slight sketch of the nervous system, some of the workings of which are not yet made out, while hitherto accepted interpretations of others are being disputed in the light of fresh discoveries which new means for investigation have revealed. I will purposely omit, as much as possible, the consideration of mental phenomena, because for the present you are not concerned with them, while in order to prepare you for next week's lecture, which is to include paralysis, abnormal sensations, convulsions, muscular wasting, and other physical manifestations of nervous disorders or injuries, I will dwell mostly on those parts of the nervous system which research and experience have proved to be chiefly involved when the above-named conditions prevail.

The nervous resembles the circulatory system in having a principal and an auxiliary system, namely, the cerebrospinal and the sympathetic. The cerebrospinal system comprises the brain, the spinal cord, and the cranial and spinal nerves, which act as lines of communication between the brain and all voluntary muscles. The spinal cord, though possessed of independent properties, also serves as a highway along which intelligence- and order-bearing messages pass between the brain and the body.

The sympathetic, or ganglionic, system mainly consists of two double sets of ganglia* lying along both sides of the spinal column, out of which passes a vast number of nerves* which communicate not only with each other but with ramifications of the cervical and spinal nerves. The sympathetic nerves follow the lines of the blood-vessels, and influence them, as they do all involuntary muscular movements, those of all *internal organs*† included. Indeed, so completely are all of these provided with their own sympathetic nerves, that each might be said to have its own clockwork or autonomy.‡ None the less it is the cerebrospinal influences that reign paramount, and they, as regards the blood-vessels and the action of the heart, when not positively antagonistic, are at least always counterbalancing.

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* Ganglia bear the same relation to the nerve fibres that connect with them as does the brain to the nerves and fibres which connect directly with it.

The nervous system also resembles the circulatory in another respect. Just as the heart is served by two classes of blood-vessels, one carrying blood to it and the other from it, so the brain is served by two sets of nerves, the afferent and the efferent. The afferent nerves, as the name implies, convey impressions from the outer world or from the extremities of the nerves to nerve centres in the brain or in the spinal cord. The efferent nerves carry impulses from the brain to the organs and muscles throughout the body. These nerves are often spoken of as sensory and motor nerves; but the terms are not, strictly speaking, synonymous, for though muscular movement is the most common result of efferent impulses, some efferent nerves instead of inducing movement positively inhibit it, and others only excite secretions, while some afferent nerves do not carry conscious sensation. As general terms, therefore, afferent and efferent are the only correct ones, though sensory and motor are appropriate for all individual sensation-producing and movement-exciting nerves.

The Brain.

The three principal masses which compose the brain are :—

1. The "cerebrum," or greater brain. This occupies the upper part of the cranium, and consists of two hemispheres, separated from each other, except for about an inch in the middle, by a deep fissure, and further subdivided by smaller fissures into five lobes each. It is owing to the number and depth of

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* The sympathetic nerve fibres differ from the spinal and cerebral in not having a second inner sheath—the fatty or soft lining known as "Schwann's sheath" or "the medullary sheath." Hence they are called *non-medullated* nerve fibres.

† Though under the immediate control of the sympathetic system of nerves, the viscera are related to centres in the spinal cord, and it is from these centres that the controlling influence is really derived, probably through the finer fibres of the anterior roots.

‡ Gowers' "Diseases of the Nervous System."

these fissures and to a multitude of convolutions in the brain, that its actual superficial area is so great, for just as a sheet of tissue paper crumpled up into a ball gives no idea of its actual size, so the small space occupied by the brain does not suggest the extent of its area (*Fig.* 29).

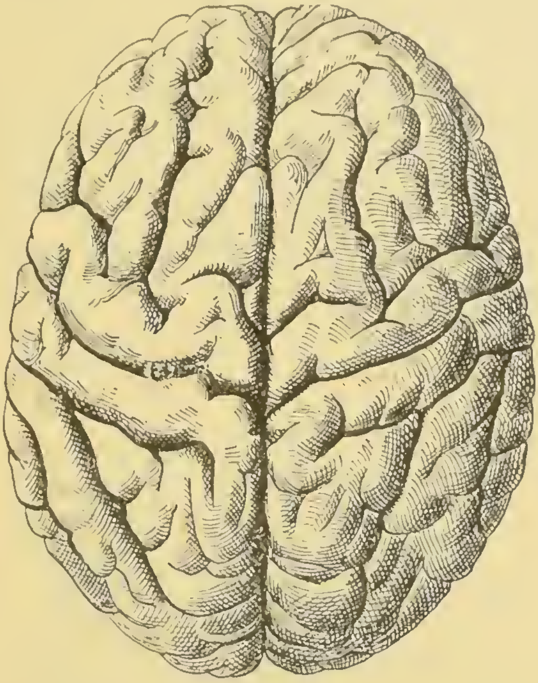

Fig. 29.—Upper surface of the brain, showing its division into two hemispheres by the great median fissure, and also its convolutions.

2. The "cerebellum," or "lesser brain." This lies below the cerebrum, and is overhung by it. Ribbed and wrinkled externally, if cut across the smooth, delicate white matter on grey matter will be seen to present a tree-like arrangement (*Fig.* 30).

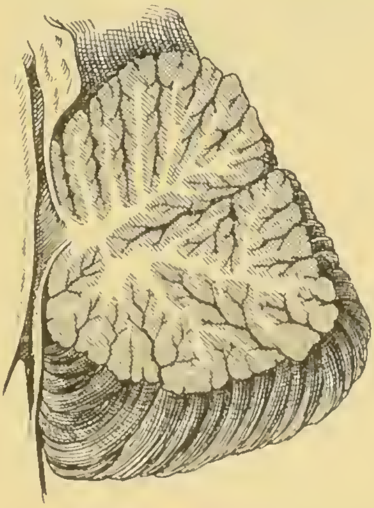

Fig. 30.—Section through the cerebellum, showing the arrangement of the white and grey matter, forming the *arbor vitæ* (tree of life).

3. The "medulla oblongata," or "bulb." This is the continuation of the spinal cord into the skull, and stands upright within the halves of the cerebrum (*Fig.* 31).

Under the brain are several pairs of ganglia (termed sometimes basal or sensory ganglia). These are the great cerebral ganglia, and the central masses of grey matter are the "centres of origin" for sensori-motor nerves (possibly reflex centres). Besides these there are various highly-complicated medullary parts, differing in shape and size, too numerous and too complicated for me to enter upon at present. All their properties are not yet understood, but whatever may be their relative impoitance, vitally, intellectually, or functionally, they are for the most part of high import, because they provide tracts for sensory and motor impulses to pass on from one part of the brain to another, or from the brain to the spinal cord, and because structurally, by their bridging and supporting strands, they provide as it were so many connecting and supporting girders, pillars, and bridges. (See *Fig.* 31 for pons varolii and the two crura cerebri.) It is as if some great central telegraph station, besides being the receiving and despatching centre for all telegraphic communication, were built up of telegraph wires so arranged as to form definite structures containing chambers provided with carefully-protected electric batteries; for in the brain there are several chambers, or ventricles as they are called, in which lie embedded vital receiving, generating, and transmitting nerve centres. It is when these

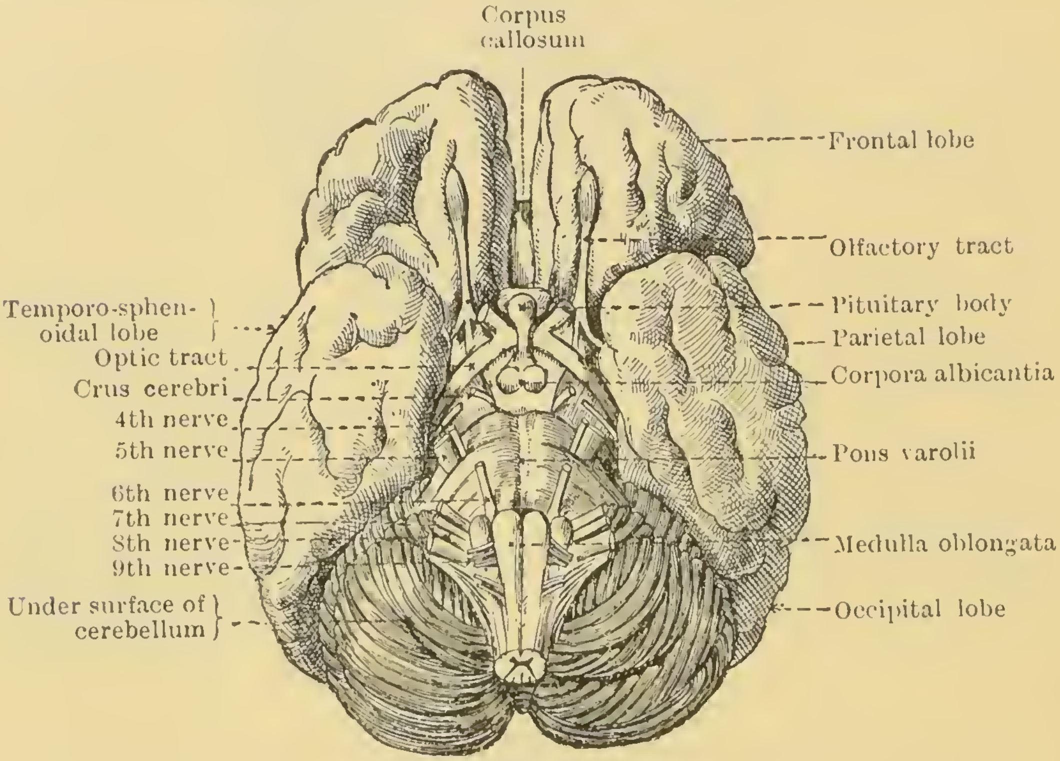

Fig. 31.—Base of the brain.

ventricles are flooded or torn by cerebral hæmorrhages that fatal results take place.

If asked to describe the uncooked brains of any animal, you would probably say that "they are white curly rounded masses of soft matter, packed together in convolutions or folds." This description as regards colour would not be very accurate, for parts of the nervous tissue of the brain are greyish, as in the spinal cord, though there the relative position of the grey and white matter differs. In the spinal cord, the grey matter lies in the centre, surrounded by the white matter, whereas in the brain the grey matter spreads to a certain depth over the outer layer, or cortex, and in the interior of the cerebrum is only dotted about (*Fig.* 32), while in the cerebellum the white and the grey are in almost the same proportion.

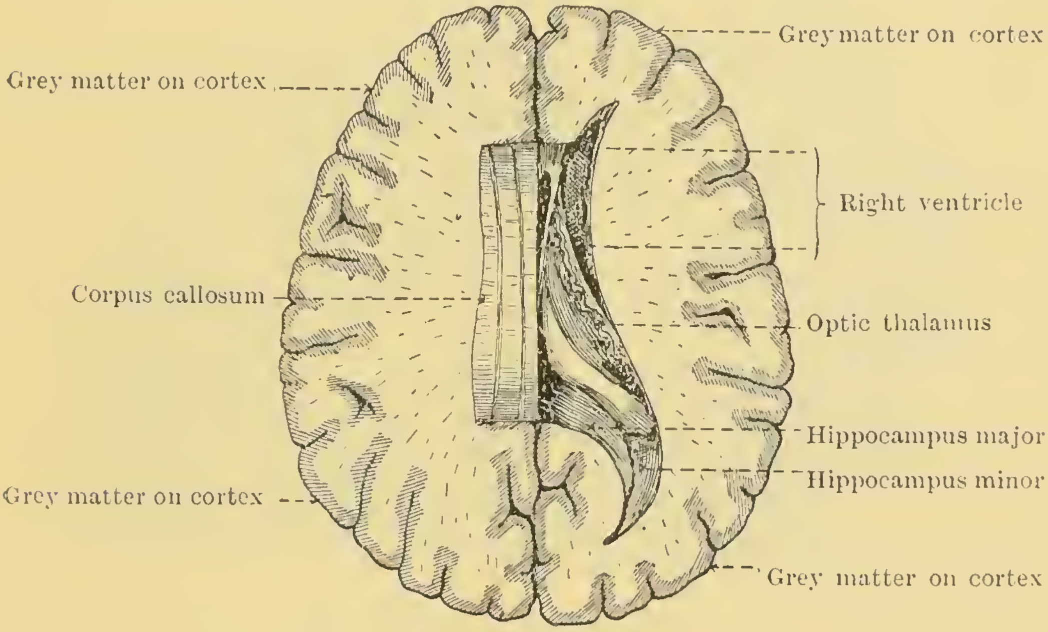

Fig. 32.—Section of cerebrum.

The grey matter is composed of nerve cells or groups of nerve cells, with interlacing fibres of very minute blood-vessels and of a special connective tissue termed neuroglia, while the white matter is made up of nervous tissue composed of masses of white nerve fibres of various sizes, divided into bundles by neuroglia, and it is these which compose those structures and bands of union about which I have just spoken.

Cerebral or Cranial Nerves.

Within the brain, and individually distinct from the masses of nervous fibre tissue which form its substance, structure, and paths of communication, are twelve pairs of nerves, or cords of nervous matter, composed of fibres bound up within a sheath.

These fibres have their origin, like other nerve fibres, in nerve-cell centres, each in fact being a prolongation of a projecting process in a nerve centre. (See *Fig.* 31.) They might be compared to threads drawn out from a mass of flax, which remain attached to their starting-points as they lengthen. The nerves connect their points of origin with the parts to which, in many branches, they pass, and their extremities are furnished with sensitive " end organs."

Of the twelve pairs of cranial nerves, only two extend beyond, or have any influence outside, the head, namely, the 10th, the pneumo-gastric or vagus, and the 11th, the spinal accessory. Four are nerves of special senses, namely, smell, sight, taste, and hearing. Five are either in part or altogether motor nerves, and as such excite the movements of the face, jaws, eyeballs, eyelids, and tongue; while the remaining three are what is called " mixed nerves," for they have both sensory and motor branches and fibres.

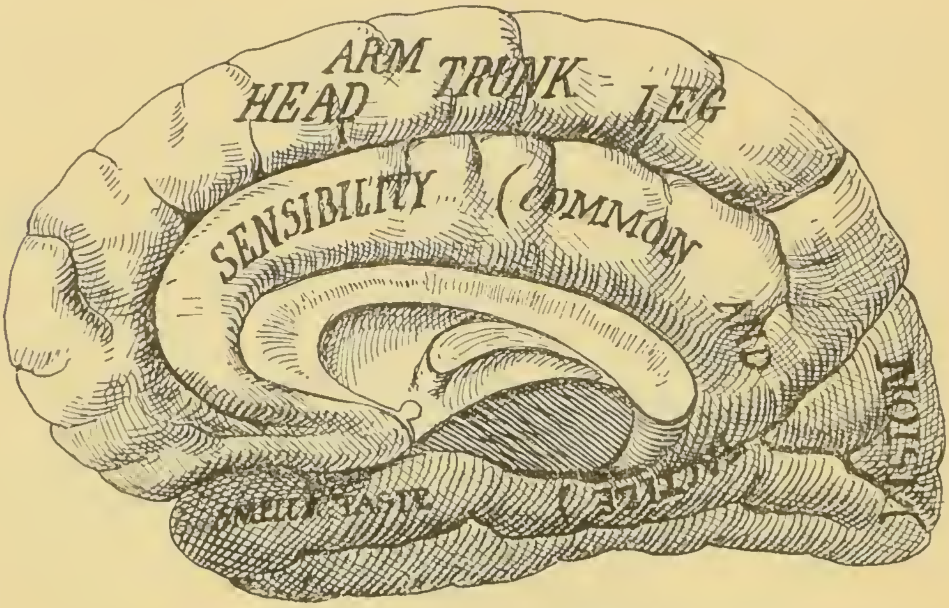

Fig. 33.—Human brain : mesial aspect of right hemisphere. To illustrate cortical localization of function.

MOTOR AREAS.

With such certainty have the relative, or, so to speak, the geographical, positions of a great number of the motor nerve-cell centres (points of origin) in the grey matter of the cortex been established (*Figs.* 33, 34) by experiments, that nowadays when a physician finds a patient with convulsions or paralysed on one side of the face or in one leg, he can as readily tell where in the brain the cause of trouble lies, as could a schoolboy point out some well-known French town on the map of France. If a leg is paralysed, the area affected would be the uppermost point of the ascending frontal lobe around the fissure of Rolando*, or if the face, then one much deeper in the same lobe. Further, he is aware that the lesion must be on the side of the brain opposite to the part paralysed, because the fibres of the cranial nerves, with one exception, cross within the brain to the side opposite their points of origin. The fibres of the motor nerve tracts cross, for the most part, in the medulla oblongata, before descending the spinal cord.

One-sided paralysis (hemiplegia) can occur only when the lesion is cerebral, for this reason, that the two hemispheres are so separate that an injury or disease of the brain does not necessarily involve both halves, whereas in the spinal cord the parts lie so close together that even the smallest lesion can scarcely fail to injure both sides.

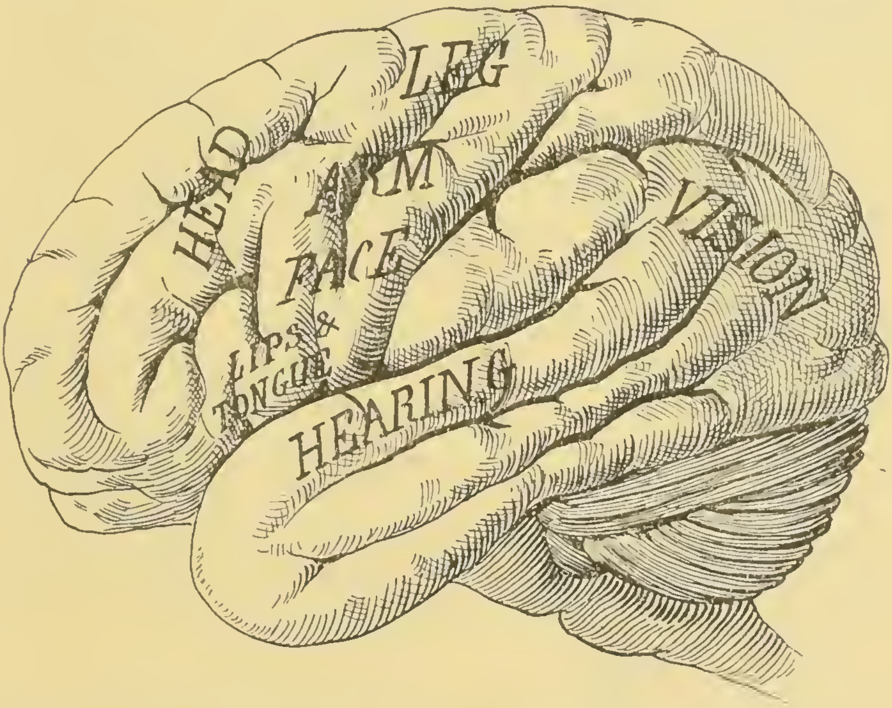

Fig. 34.—Human brain: lateral aspect of left hemisphere. To illustrate cortical localization of function.

Occasionally in " system diseases " paralysis is confined to one side, or may affect one side earlier than the other, but such cases are rare.

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* The *fissure of Rolando* separates the frontal lobe in front from the parietal lobe behind. The *fissure of Sylvius* separates the temporo-sphenoidal lobe below from the frontal and parietal lobes above. It begins as a wide-lipped opening below, and divides into a long horizontal branch and a short vertical one, round which the third frontal lobe curves, merging into the lower end of the ascending frontal. The region they join in is sometimes called the operculum: it covers the island of Reil below.—*From Ormerod's "Diseases of the Nervous System."*

THE SPINAL CORD AND SPINAL NERVES.

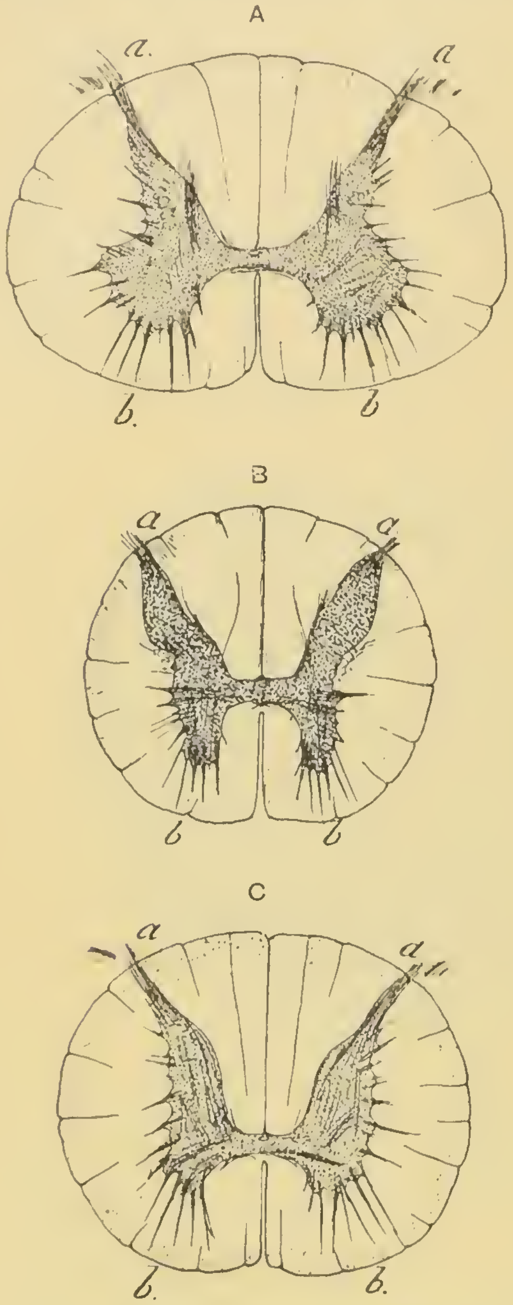

Fig. 35.—Spinal sections showing relative positions of the grey and white matter.

A, Cervical; B, Dorsal; C, Lumbar. *a a*, posterior horns or cornua; *b b*, anterior horns or cornua.

The spinal cord, which averages about eighteen inches in length, and in thickness that of the little finger, lies in a bony channel within the vertebral column, and like the brain is well protected by three enveloping membranes: that next its surface, the delicate blood-supplying pia mater; the intermediate transparent serous membrane, the arachnoid; and the external hard fibrous dura mater.

The cord is composed of the same nervous tissues as the brain, only differently arranged. For instance, its white fibre strands go solely to form its upright strands or columns, while the grey matter is so placed as to produce in the centre a distinct pattern on the surrounding white matter. This is clearly seen if a transverse section of a vertebral segment be made (*Fig.* 35), just as when you cut an orange across you see the white central and division-forming parts making a regular pattern on the yellow pulp. In the spinal cord, however, the grey matter does not spread in marked lines of division, for the white columns are covered with sheaths of connective tissue so minute and so similar in colour to the mass of white fibres, that the individual columns or "tracts" are not discernible to the naked eye.*

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* "They are not distinguishable in the *healthy* cord of an adult anatomically, but their existence is determined partly by the definite courses taken by degenerative processes, primary or secondary, in the cord; partly by the differences in the date of that development, the date, that is, at which the nerve fibres of the various 'tracts' become clothed with myeline."—*From Ormerod's "Diseases of the Nervous System."*

But they are none the less absolutely separate, with different origins, terminations, and functions, disease often attacking one and leaving its neighbour untouched. Some are ascending, or sensory, tracts, carrying impressions to the brain from the spine, and through it from all parts of the body; others are descending, or motor, tracts, carrying impulses from the brain. The former act upon the posterior and the latter upon the anterior nerve roots (*Fig.* 36), and connect each other by passing somehow across their roots. The motor tracts give off some of their fibres high up in the spine, others by degrees lower down in it, while the fibres of the sensory tracts begin to ascend the spine low down in it, and others not till farther and farther up. Hence some fibres and whole tracts have longer and some shorter courses, and it is this process of giving off and taking on—a process more abundant in some parts than in others—which creates variations in the size and shape of the spinal cord.

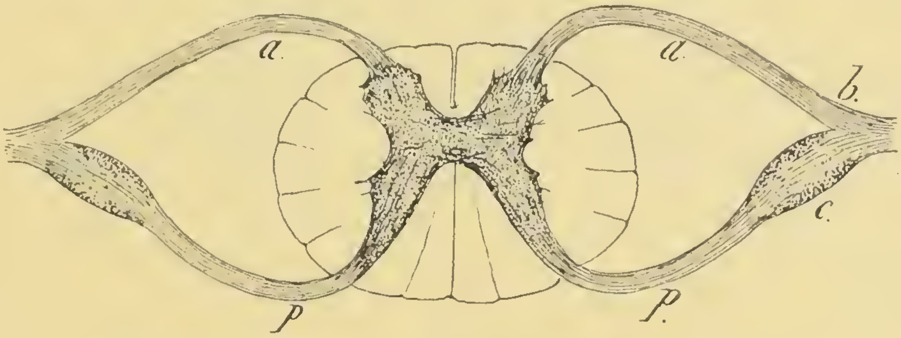

Fig. 36.—Transverse section through the spinal cord.
a a, anterior or motor roots; *b*, point of union in *c*, ganglion; *p p*, posterior or sensory roots.

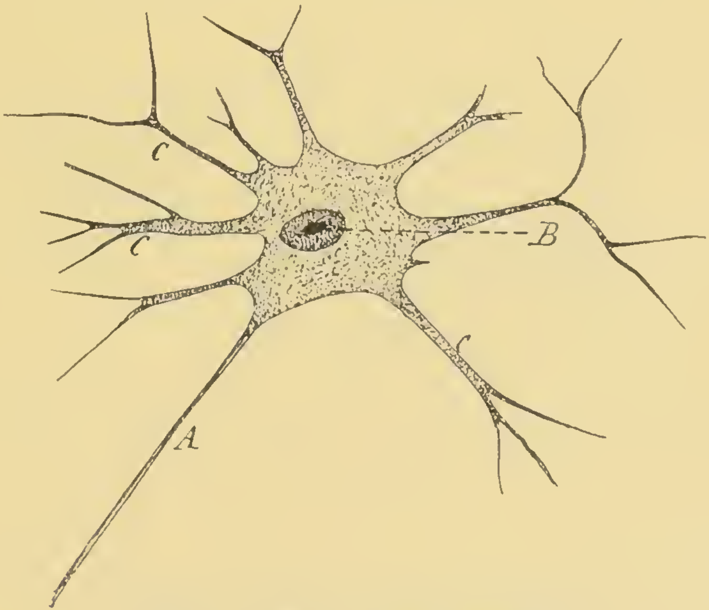

Fig. 37.—Nerve cell (highly magnified).
A, axis cylinder or nerve process, containing core or filament of the nerve: *B*, pigment; *C*, short processes.

From the spinal cord branch off thirty-one pairs of nerves to right and to left through openings between the vertebræ. Each has a double set of roots whose fibres have their centres in nerve cells (*Fig.* 37) in the front and back horns of the spinal grey matter. Those from the front are known as the anterior or motor roots, and those from the back as the posterior or sensory. Outside the spine they unite to form mixed single nerve trunks, dividing and subdividing into branches as they pass to the skin and to the muscles of the back and limbs, etc. (*Fig.* 38.)

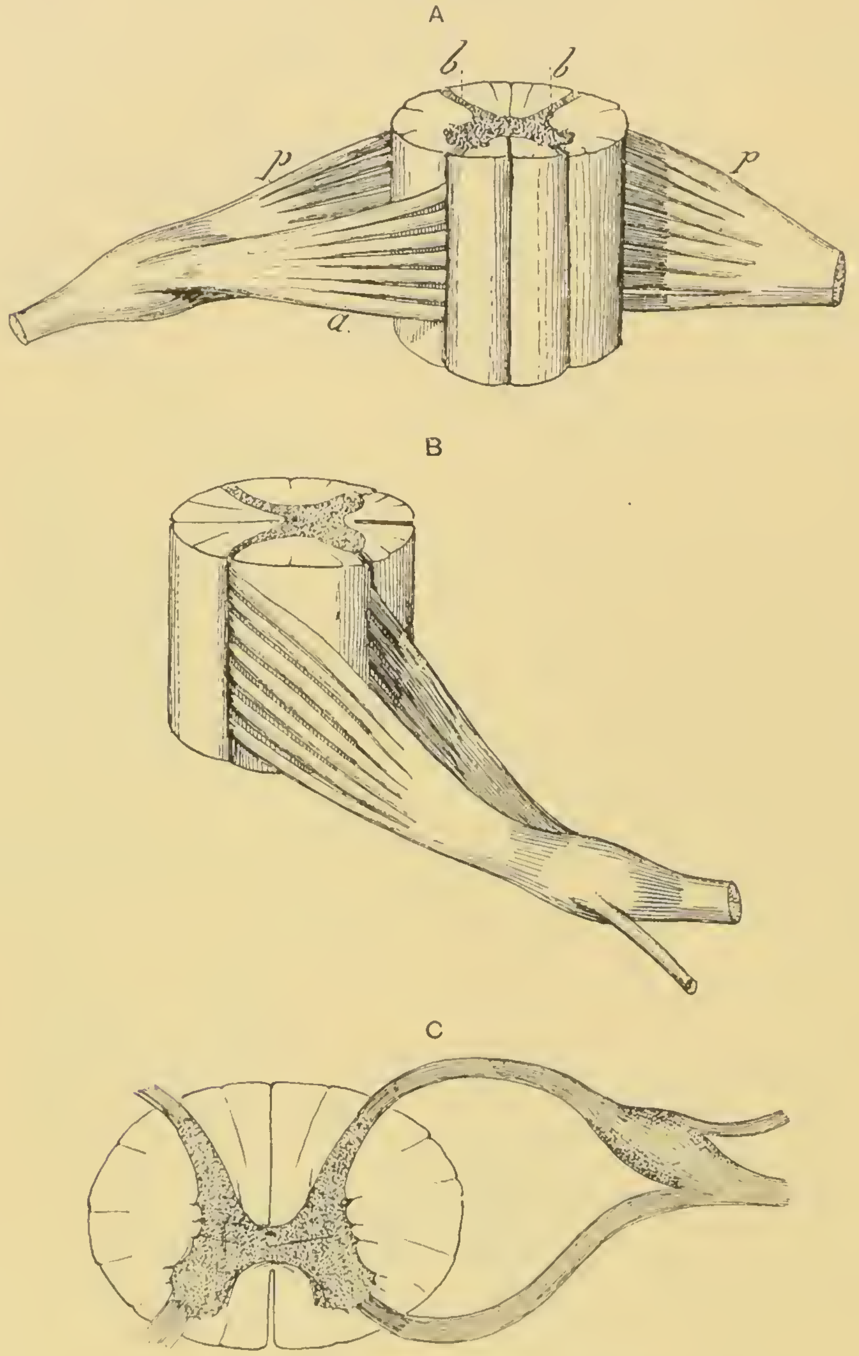

Fig. 38.—Roots of a spinal nerve issuing from the cord.
A, from before (*a*, anterior root ; *b*, groove of the cord ; *p*, posterior root) ;
B, from the side ; C, from above.

It is important to remember the distinction between the posterior and the anterior horns, or cornua, of the spinal grey matter, and between the posterior and the anterior roots of the spinal nerves; also the difference between descending and ascending white columns, for when, in the next lecture, we study the symptoms of "infantile paralysis" and of "locomotor ataxy," you will learn that disease in the anterior horns of the grey matter is the main cause of the former with its marked atrophy, while disease in an ascending white column is answerable for some of the strange conditions seen in the latter.

The spinal cord, besides being a highway of communication between itself and the brain, and through its nerves with the rest of the body, possesses centres for what are called "reflex" or involuntary actions, and by right of these it fills the part of an acting governor within a sovereign-ruled empire. In this particular, again, you have to remember the local and functional difference between the posterior and the anterior portions of the spinal grey matter and between the posterior and the anterior spinal nerve roots.

"Reflex actions" mean impulses brought by sensory nerves acting as stimulants on nerve centres and their rearrangement in the said centres, which in the spine are situated in the posterior horns of its grey matter on each half of the cord. This rearrangement includes passing the stimulus from the posterior to the anterior side, and then sending it forth by motor nerves to excite appropriate muscular movements. This is the simple process of a purely reflex action, such as occurs in ordinary involuntary movements. Where movements are voluntary and there is consciousness of sensation, the stimulus has in addition to be passed on across anterior motor centres to posterior ones, and on by those of an ascending column to the brain centres. Reflex actions are not confined to the spinal cord—they are everywhere—but perhaps nowhere else in the body do they exercise offices so great and so apparent. Even such so-called automatic acts as respiration, the beating of the heart, and the winking of the eyelids are more or less reflex acts, though when exaggerated or hindered through brain influence, they in part cease to be so; for example, when there is protracted retention of the breath, or non-recoil of a limb from what hurts it, or retention of urine or fæces, in spite of pressure on the anus or bladder exciting to relaxation.

In the nursing of paralytic patients you may come across examples of the survival of power for reflex actions in cases where damaged brain centres or interrupted connections between the brain and spine have led to loss of voluntary movement. In such patients a leg if pricked might draw back, or you might find that a paralysed leg had somewhat changed its position in the bed. You must not conclude from this that your patient could move if he chose, or that the leg was bewitched, but must take it as a proof that of the nervous apparatus which provides for activity and sensitiveness, only one half—that providing for unconscious sensation and movement—is in working order. In the first instance such a patient is not mentally aware of the prick; in the second, pressure of the bedclothes might have excited the sensory leg nerves, or possibly poison in the blood might stimulate the leg nerve centres in the spine to send forth motor impulses, of all which the patient knows nothing.

Reflex actions are abolished if either the sensory or the motor nerves of a cell are damaged, or are severed from their cell centres, or if their cell centres are destroyed; and in consequence either temporarily or permanently the paralysis of that limb would be complete as regards both involuntary and voluntary movement, for the apparatus of the brain being no longer intact, it cannot get its orders carried out. Paralysis is permanent if cell centres are destroyed, for they can never recover, but nerve fibres may, and even if severed at the point of origin (the nerve-cell centres), regeneration may take place by "fresh processes" starting in the cells, out of which new fibres will grow. Their regeneration takes place only if the nerve cell is undamaged, just as a plant may have its main stem cut down* to the roots, and yet fresh stems shoot forth, showing soundness of the root, whereas another plant which has had the core of its root effectually injured, cannot produce fresh stems.

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* "Direct union between severed ends of nerve fibres does not take place, but regeneration of a nerve comes by growth from the intact ends of the fibres of fresh ones. Ranvier compares the result of cutting a nerve fibre, 'in the causing the growth of a number of new fibres in place of the original one, to that produced when the leading shoot of a plant is removed, and when the production of a number of lateral buds follows.'"—*From Quain's "Anatomy."*

SUBJECT IX continued.—LECTURE 2

A "STROKE": ITS CEREBRAL ORIGIN—INFANTILE PARALYSIS: ITS SPINAL ORIGIN—LOCOMOTOR ATAXY: ITS SPINAL ORIGIN—THE PARALYSIS OF PERIPHERAL NEURITIS.

PARALYSIS is not a primary disease, but the outcome of some lesion or disorder of the nervous system, in the brain or in the spinal cord, or in the nerves; just as dropsy is not in itself a disease, but the outcome of diseases or of some disorder of the circulatory system, the blood-vessels, or the lymphatics.

A probationer once said to me, "What is the difference between apoplexy and paralysis?" Doubtless she had sometimes heard power-bereft persons spoken of as "sufferers from paralysis," and at other times as "stricken by apoplexy." It was explained to her that apoplexy and paralysis stand to each other as cause to effect, though paralysis might be induced by other causes than the bursting of a blood-vessel in the brain (apoplexy). In apoplexy, the hæmorrhage causes destruction of or temporary damage to brain centres, and hence the loss of motor and sensory power. Connection once interrupted, stimulation is no longer excited, and intelligence through touch does not reach the brain; the limbs are not prompted to movement, and as the brain learns nothing of the outside influences that affect them, no orders are given to the limbs.

But, as I have just said, cerebral hæmorrhage is not the sole cause of paralysis. Wounds, pressure, inflammation, or any deterioration or damage of the nervous tissues of the cerebro-spinal system or of separate nerves will lead either to exaggeration of the functions of the organs or of the parts affected, or to a cessation of their function, which means paralysis. Paralysis may occur, for example, consequent on cerebral embolisms or thrombi, either owing to pressure or because such obstacles in the cerebral blood-vessels tend to block or to cut off blood-supply from a portion of the brain, and so induce inertness and ultimately softening of the brain tissues. Paralysis may also follow from pressure by abscesses, "new growths," or pieces of bone consequent on fractures of the skull; likewise when there is progressive disease producing either hardening or softening of brain or spinal matter, and whenever there is injury to the spinal cord.

As the time at our disposal is short, I will limit myself to four types of paralytic affections, in order to illustrate the different effects that result from differences in localization of lesions in the nerve tissues, lesions the victims of which demand your best nursing because of the disablement they cause. I will purposely not touch on mental symptoms, at least where they constitute mental cases.

We will take first, severe exhibitions of the paralysis popularly called " strokes," whether due to effusions of blood or serum on the brain, or to clots in the arteries ; then, " infantile paralysis," and " locomotor ataxy," both of which have a spinal origin ; and lastly, the paralysis caused by inflammation or deterioration in the trunk, branches, sheaths, or terminations of a nerve or nerves. When the terminations are attacked more or less throughout the body, this then is called " general neuritis," and when inflammation is due to alcoholism, " alcoholic paraplegia."

Differences in degree, character, distribution, and limitation depend on the situation of the exciting lesion and on its extent, but chiefly on position, and terms have been adopted expressive of these differences. Of these, here are some with which you would do well to familiarize yourselves, as they will help you to follow what I, and other lecturers on this subject, say.

Hemiplegia is paralysis of one lateral half of the body, due to a lesion in the brain on the side opposite to the half of the body affected.

Paraplegia is the term used to express paralysis of both sides of the body below the waist, commonly due to spinal injury or disease, though it may be brought about by reflex action from trouble elsewhere. The term applies also to general paralysis.

Monoplegia signifies paralysis of a single nerve, limb, or part of the body. Its origin may be cerebral, spinal, or neural.

Anæsthesia expresses insensibility, and *hyperæsthesia* excessive sensibility.

Paresis is slight imperfect paralysis of a part, as, for example, facial paresis.

A " STROKE."

Paralytic strokes from apoplexy are commoner in men than in women. They are rarely seen in the young, and comparatively rarely in the middle-aged except as the result of an accident, say a fall on the head, or where some morbid condition of the blood-vessels forestalls senile deterioration, as in heart cases, or in Bright's disease, where the accompanying high blood-pressure tends to produce hæmorrhages. That cerebral vessels burst more commonly than others seems due to the fact that they lie in softer surroundings than do other blood-vessels.

The characteristics of an apoplectic seizure are: sudden and complete unconsciousness; hemiplegia; stertorous breathing; slow laboured pulse; face flushed at first, then getting pale; dilated or unequal pupils; eyes non-sensitive to light; distortion of the face towards the paralysed side, with puffing out of the cheek on the affected side. Along with the facial muscles those of the eyeballs and eyelids are affected, except in certain lesions when they escape. In a lesion of the crus cerebri the eyeball will be paralysed, but on the opposite side to the facial muscles. The symptoms I have named may not all be present. The patient may not become quite unconscious, or the paralysis may not be sudden. In some cases a seizure is preceded by transitory giddiness and a creeping sensation, while others awake to find themselves paralysed, or both paralysis and unconsciousness may gradually advance—a combination that does not speak well for the chances of life. Again, instead of being flaccid and powerless, the limbs for a time may be rigid, convulsed, or painful, and the loss of sensation throughout be, in proportion, less than is the loss of motor power.

A stricken patient must be kept exceedingly quiet, with the head raised, and usually mustard blisters are applied to the calves of the legs, or the doctor may even deem it advisable to bleed him. Should the skin turn chilly, or the temperature fall below normal—symptoms of collapse for which you should be watching—recourse must be had to warm applications and stimulants. Further, during unconsciousness attention must early be paid to drawing off the urine, if not otherwise passed, so as to avoid distention of the bladder taking place.

In the worst cases consciousness does not return, and death ensues in two to three days, or perhaps later. But the period of unconsciousness is not the only anxious one, for reaction, with its raised temperature and laboured breathing, may bring with it pneumonia, or some other form of congestion of the lungs, resulting in death. Where the throat or any part of the respiratory apparatus is involved, the struggle for life is hard and the nurse's work a difficult one.

The earlier the return to consciousness the better the chances of life, and the sooner improvement sets in the more rapid its progress is likely to be. Return of sensation commonly precedes the return of motor power, and the course of recovery is usually from the hip down the leg to the foot, and then from the shoulder to the arm, hand (the reverse may occur), and finally the fingers, though these often remain paralysed.

Most paralysed patients are irritable, and therefore great patience and firmness, and surely, too, unfailing indulgent sympathy, must be exercised by those in charge of them, especially if to the strain, exasperation, and humiliation of powerlessness, pain is added. The nurse's work does not become much lighter once danger is passed, for there may be incontinence of urine and fæces, or retention and constipation, one or other of these conditions being always present in serious cases of paraplegia. The former necessitates the skin of the patient being kept absolutely clean and dry, and the latter, a skilful use of the catheter and enemas. The catheter is a dangerous instrument in the hands of a careless or ignorant nurse, who may cause infection of the bladder if she fails to keep it absolutely aseptic by thorough cleansing with antiseptics, or by boiling when it admits of boiling, and enemas have to be given with great care and patience.

As to bedsores—always to be feared when there is immobility—they are doubly to be guarded against where, besides immobility, the skin is insensible. Nothing in your profession calls for more ceaseless care than the prevention of bedsores in such cases, and experience will prove to you how largely a nurse's reputation turns on her success in their prevention or on their cure when present, especially had her predecessor proved careless or inefficient.

The points to aim at for the prevention of bedsores on prominent parts, such as the heels, sacrum, elbows, and shoulders, are: (1) The prevention of pressure, since pressure arrests circulation; (2) The cleansing, stimulating, and hardening of the skin; (3) Keeping the skin absolutely dry.

1. Water-beds are most helpful, but where not to be had you must fall back on "nests" or pads, and on frequently moving the patient. Keep the sheets free from creases by pinning the draw-sheet through to the mattress. The patient should not lie on a nightdress, as it would become creased.

2. Wash with soap and water, and then rub or paint on some spirit, or Pond's Extract, or any stimulant ordered by the doctor, or where the patient's skin cannot stand these, lightly rub on an ointment.

3. Use a dusting-powder (starch with zinc or boracic powder), and where there is loss of control of the urine and fæces, a little lanolin or other ointment is required as a protection against the harmful action of the damp they produce.

A sore once formed may have to be poulticed with linseed or boracic, and with these or any cleansing or stimulating dressing, care must be taken that the poultice or dressing be no larger than the sore, so as not to involve sound tissue. The tendency to bedsores is greatest in paralysis of spinal origin, and in the reactions of hemiplegia of which I spoke to you. They often defy the best care and treatment, and will even eat down to the bone, so hastening death from exhaustion.

INFANTILE PARALYSIS.

Infantile paralysis is thought to result from an inflammation in the spinal cord confined almost exclusively to the anterior portions of its grey matter. The extent and rapidity with which the muscles waste are in striking contrast to the slower muscular wasting of paralysis of cerebral origin. Though not unknown in adults, infantile paralysis, as its name implies, is *par excellence* a disease of young children. A child, often a fine healthy child, is suddenly seized with fever, and maybe with pains in the head, and fits of vomiting or convulsions, while the paralysis itself does not become apparent till some days later. It is usually progressive for a few days, and then, in favourable cases, motor power begins to return. The muscular wasting does not yield so soon or so steadily, and atrophy almost always remains for life in one or more of the parts which had been paralysed.

It differs from hemiplegia and paraplegia as to localization, for the arm on one side and the leg on the other may be affected, or one set of muscles and not their companion or antagonistic ones, and it does not affect the rectum or the bladder.

Though not very dangerous even in its crisis, and rarely fatal (when so, it is probably because inflammation has spread into the medulla, where lie, as it were, the springs of life), yet infantile paralysis is to be dreaded by reason of the permanent deformity consequent on its peculiarity, that of imperfect recovery. This deformity may be seen in a club foot, or in a withered distorted hand, the distortion being due to only one set of muscles acting; for in a sound limb, the pulling of one set is counterbalanced by that of an opposing set of muscles, but in these cases the opposing set has lost its power. Sometimes infantile paralysis may interfere with the development of whole limbs, as in a girl I knew, who at sixteen, with a handsome face and a fine womanly bust, had legs so tiny and powerless that to move about upright not only had she to have crutches, but also iron supports from the waist down into her boots. Without this apparatus she could only crawl on the floor like a beast. In the beginning of the illness, or fever-provoking stage, the child must be kept flat, and have either counter-irritants or ice bags applied to the spine, and perhaps ergot or belladonna may be ordered.

When the period of regression is thoroughly established, recourse will be had to working the limbs and to electricity, in order to stimulate the atrophied muscles, and to prevent deformity progressing. You may perhaps be expected to carry it on, in which case you must be very careful not to make mistakes in the strength of the electricity ordered, and when it can be done not to neglect to remove an electrode till you have turned off the electricity, for children so readily become frightened or excited, and at best it is difficult to prevail on a child to bear the shocks of the interrupted current of the strength required to make muscles contract. You must see that the child while under your care does not make voluntary movements whilst the muscles are still unevenly affected, especially if in the back, for thereby deformities will the sooner result, and the younger the child the more unfortunate this is.

Locomotor Ataxy.

Whereas in infantile paralysis the seat of trouble lies in the grey matter of the anterior horns of the spinal cord, in locomotor ataxy (sometimes called "tabes dorsalis,"* that is, wasting of the back), the degeneration mainly takes place in the posterior sensory tracts and in the peripheral sensory nerves.† The disease is commonly localized in the lumbar segments of the spine, but it may advance into other divisions or start in the dorsal or cervical ones. It may also affect motor tracts, and so add motor paralysis to sensory.

When there is disease of the posterior sensory tracts of the lumbar segments, the following conditions usually prevail:—(1) Unsteady gait, from lack of harmony in muscular actions. (2) The patient feels as if he walked on air-cushions or heaps of sand or cotton-wool, while if he tries to walk in the dark or with his eyes closed, he falls. (3) There is sometimes squinting, and the pupils fail to contract to the stimulus of light, though accommodation for near vision is unimpaired. (4) There are lancinating or "lightning," or "girdle," pains, or a sense of needles and pins in the legs, with considerable skin insensibility; or, on the contrary, these spontaneous pains may be in the skin, and so acute that the slightest touch from the bedclothes or aught else cannot be borne. In some, the suffering caused by the "lightning pains" is terrible, in others the pain is slight enough to pass for rheumatism, while, again, the character of the pain is so like blows from a sledge-hammer as to make the patient scream out. (5) The "knee-jerk" (or "patellar tendon reflex") is absent. This symptom is now considered by the medical profession to be the deciding evidence of locomotor ataxy, when combined with any of the other symptoms mentioned, no one of them being thought entirely conclusive, for the reason that they may be absent in the early and even in the later stages of the disease.

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* Since the discovery of how much its symptoms may be due to disease of the peripheral nerves, the term "peripheral neural tabes" has also been applied to the malady.

† Dr. Thomas Savill holds strongly that sclerosis of the posterior spinal column is not the *primary* degeneration of tabes dorsalis, but that it starts in a deranging atrophy of the nerve fibre endings and corresponding degeneration of muscle fibres. This theory offers an explanation of the fact that though in the majority of cases sclerosis in the posterior columns is found after death, in a few well-established cases of tabes dorsalis it could not be detected; for, according to Dr. Savill this would mean that the disease had not passed into its secondary stage by the time the patient died.

Besides these typical symptoms of tabes dorsalis, some striking accessory ones are sometimes associated with them :—(1) A perforating ulcer on the sole of an insensible foot, which begins like a hard corn and, with care, heals. (2) Arthritic affections resembling rheumatoid arthritis, which, though not very painful, disorganize the joints (Charcot's disease). (3) Violent gastric crisis or vomiting. (4) (Rare) Herpetic-like eruptions. A sad tale of miseries !

When, over and above the troubles characteristic of this disease connected with the bladder and rectum, there is incapacitating suffering, and an increasing loss of power in the limbs, such patients are pitiably dependent on the good offices of the nurse, and there is much for her to do.

Life may be protracted for many years, or may be cut short in two or three, death resulting from some intercurrent affection, such as pneumonia or cystitis, rather than from the malady itself.

Locomotor ataxy may be due to an accident, excessive fatigue, or exposure to cold, or may be hereditary ; but the greater number of its victims are persons tainted with syphilis.

The Paralysis of Peripheral Neuritis.

Finally, let us consider paralysis of neither cerebral nor spinal origin, but as resulting from inflammatory deterioration of the nerves in their sheaths, trunks, branches, or terminations. The irritation of inflammation at first excites pain in the nerves, but as its destructive effects progress, pain is succeeded by muscular wasting and paralysis throughout the region supplied by the affected nerve or nerves. This constitutes the difference between neuritis, and neuralgia, for in the latter, pain is the ruling and sole symptom.

There may be neuritis of a single nerve, of a group of nerves, or of several groups, or it may prevail generally throughout the whole body among the nerve terminations. In the latter event it is called " general " or " peripheral " neuritis.

This neuritis follows on many disorders, such as rheumatism, gout, diabetes, and lead poisoning. It may also result from exposure to cold, septicæmia, infectious fevers, or poisonous drugs, or most frequently from alcohol poisoning.

We will discuss the symptoms where " drink " has been the exciting cause, because they are most typical of general neuritis, and are also those you are most likely to have to do with.

Its subjects, I am sorry to say, are generally women, who long have been in the habit of drinking spirits heavily. The first symptoms are cramps, "pins and needles," gnawing or burning pains, and dead fingers, while the later symptoms are an insensible condition of the skin as compared with that of the muscles, especially in the calves of the legs, and increasing wasting and weakness, leading to paralysis, first of the legs then of the arms. Possibly some heart or respiratory nerve may become involved, and there will be dullness of intelligence, loss of memory, and ataxy. Rapid muscular wasting distinguishes this paralysis from post-diphtheritic paralysis or that of lead-poisoning (most marked by the "dropped hand"), for in the latter there is seldom sensory loss, and there is the characteristic blue line round the gums, while in the former unsteadiness of gait and misdirection of the movements of the hands are symptoms that suggest locomotor ataxy.

The whole nervous system may be so poisoned, or the liver or kidneys so diseased, through alcoholism, that recovery is impossible; though if these organs are not seriously damaged, and if the drinking habit is completely broken off, recovery may be brought about even in as short a time as six weeks, by rest in bed, warmth, good food, and iodide of potassium.

Some Explanations of the Diversity of Physical Conditions in Paralytic Cases, and of Apparent Contradictions in Symptoms.

If you nurse many paralysed persons you will be struck by the variety and physical conditions in some cases, and by the contradictory nature of their symptoms.

We have seen how "strokes" are -sometimes preceded by "creeping" or other abnormal sensations, and how limbs before they become flaccid may be rigid, painful, or convulsed. In some cases of paraplegia, though the limbs are insensible and powerless, in the trunk there may be a zone of pain, so too in locomotor ataxy, in spite of the sense of touch being defective in the feet, the legs may be racked with lightning pains, and in the abdomen, along with "girdle pains" there may be hyperæsthesia just above the highest level of the exciting lesion. In infantile paralysis, though there is much muscular wasting, there is little or no loss of sensitiveness; neither is there in "spastic paraplegia," the characteristic feature of which is a convulsive rigidity of the limbs with exaggerated reflex actions; at least this is so if the sclerosis, or hardening, which is the exciting cause, remains confined to the lateral motor tracts* of the spinal cord;

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* Degeneration of the pyramidal tracts.

but if it spreads, as it often does, into the sensory tracts or into the brain, cerebral symptoms will complicate matters.

No one explanation can hold good for the apparent contradiction of combined symptoms, but there is one which can be applied to a large majority of such cases. It is this. Whenever in nerves, nerve fibres, nerve centres, or nerve end-organs, irritation precedes destruction, exaggeration or perversion of their functions results. If the nerves concerned are sensory, pains of all kinds; if motor, over-development of muscular contractility amounting to cramps, twitchings, spasms, or convulsions; if of hearing, a sense of noises not excited by external sounds; and if of sight, such optical sensations as sparks or flashes, not produced externally, will occur.

Let me take, as an example of transition from irritation to destruction, with a corresponding exaggeration of function followed by annihilation, the effects an abscess in the brain on the motor area of an arm. At first the abscess excites abnormal muscular contractions such as convulsions, etc., in the arm on the opposite side, till through either increased pressure or inflammation, the arm nerve centres are destroyed and paralysis of the arm is the result. If the inflammation be of a spreading character, the parts first attacked will soonest become paralysed, while in their surrounding parts, pains or spasms may prevail till paralysis supervenes there too; or both conditions may continue if the advancing inflammation lessens.

In short, while natural stimulation excites to healthy functional activity, be it of sight, hearing, taste, touch, movement, or thought, the irritation that comes of disease, of inflammation, of poisons, or of the processes of degeneration in nervous tissues, will first exaggerate and finally extinguish functional activity, so that blindness, deafness, anæsthesia, motor paralysis, or idiocy results, according to the nerve centres attacked.

Disease in more than one part of the nervous system would account for diversity of or contradiction in symptoms, and so would survival of reflex action when power for voluntary action was lost.

The paralytic affections we have been considering afford sufficient examples of differences of condition and of opposed symptoms consequent on the localization of the lesions, and on whether the resulting damage is advancing or is complete. The seat of disease in locomotor ataxy being in the spinal sensory tracts accounts for its characteristic symptom, inco-ordination of muscular movements, which symptom has been explained by the theory that defective or misleading muscle-sensory impressions lead the brain to excite the muscles to make inappropriate movements. In infantile paralysis the inflammation, inasmuch as it affects more especially the anterior horns of the spinal grey matter and the anterior motor tracts, produces, along with motor paralysis, great muscular wasting. In spastic paraplegia, a less common affection, deterioration takes place in the lateral tracts, and its peculiarity—convulsive rigidity of limbs, with exaggeration of reflex action—has been explained on the supposition that sclerosis (hardening) in the lateral tracts more or less blocks the influences of the brain down these paths, and that therefore when reflex actions are started by sensory impulses or by recipient transferring spinal nerve centres, responsive motor ones run riot from lack of cerebral control. In paralysis consequent on cerebral hæmorrhages or on embolisms, we saw loss of consciousness. Had we turned our attention to "general paralysis of the insane," which is due to disseminated disease advancing through tracts in the spinal cord and in the brain, or had we studied the effects of abscesses on the brain, we would have found painful mental symptoms in addition to the bodily ones, but on these I have purposely not touched.

We might compare what happens in locomotor ataxy to a house door-bell, with its handle so badly adjusted that it is impossible to so pull on the wire as to make the bell ring, hence the occupants hear at best but a scraping sound. Spastic paraplegia, on the other hand, might be compared to a bell with some hitch in its attachments, which causes it to go on ringing though a hand no longer pulls it; and the complete unresponsiveness of hemiplegia might be compared to an electric bell which, when struck, yields no sound, either because water or some needful chemical is lacking, or because the electric connection has been interrupted.

SUBJECT X

DROPSY: WHAT IT IS AND WHAT IT IS NOT

LECTURE I

SOME OF THE CAUSES OF DROPSY

I HAVE little doubt that you have often heard it said, and possibly you have stated as an accepted fact, that so-and-so "died of dropsy," but that can never be a correct statement, even if death has been brought about by a drowning dropsy, for dropsy is not a disease, but "the outcome of some positive disease"—a result, not a cause, like the suffocating phlegm which a choking old man or small child dying of bronchitis cannot expectorate.

In the first place I should like to draw your attention to the fact that doctors seldom use the word dropsy, but rather "œdema"—the medical term expressive of water throughout the tissues; or possibly "anasarca," a name employed when the fluid lies in the more superficial parts of the body. You would do well to accustom yourselves to the meaning and use of these terms, especially when speaking to, or before, uneducated dropsical patients, who in all probability would not understand the meaning of œdema, and so would not be needlessly alarmed, for as a rule such persons look upon dropsy as a necessarily fatal evil. But as a matter of fact, though it is very often a most ominous symptom, it can in some cases be cured by successful treatment of the inducing causes, or can be long kept under by a judicious use of diuretics, stimulants, and purgatives, or even punctures and tappings, which in some cases may just be what gives a weak and overtaxed organ a chance of recovering and of better fulfilling its functions, other conditions being favourable.

When fluid collects locally round or in some organ, distinctive names are used. *Hydrocephalus* signifies water on the brain; *Hydrothorax*, water on the lungs; *Hydropericardium*, water on the pericardium (the membranous covering of the heart); and *Ascites*, water in the abdominal cavities. But doctors do sometimes make use of the more general term, and speak of œdema of the lungs or of the heart, or even apply it to the exudation of erysipelas, which in reality is not a true œdema, and is more correctly known as "inflammatory œdema." Besides the last named there are other distending elements, the various exudates of localized inflammation, which must not be confounded with œdema, such as serum, pus, and synovia. An effusion of synovia on the knee constitutes that well-known and common malady, "housemaid's knee."* This fluid is secreted at all times by the synovial membrane which lines the cavities of joints, where it serves, like a lubricating oil, to facilitate the gliding movements of their articulating surfaces and of the tendons attached to them. It is viscid and glairy, hence a knee swollen by an effusion of the synovial fluid does not present quite so puffy an appearance as one distended by œdema. The deciding evidence of the existence of water over and above increased size and distension of the skin, is that the depression caused by pressure of a finger remains for some time after the finger is withdrawn. This is called "pitting," and the explanation of this peculiarity is, that water takes longer to return over a spot from which it has been driven by pressure than healthy tissues take to spring back and obliterate a finger mark. For pus there is no such obvious test, but the practised eye and fingers of a doctor will in most cases readily detect its presence, and if you carefully watch a doctor's testing fingers, or get a staff nurse to teach you, you too will come to recognize how differently pus moves under pressure, and how different to the touch it is from the water of œdema. When deep seated, this is not so simple.

The Development of Dropsy.

For the most part dropsy follows on a seriously impeded capillary circulation combined with retarded venous return, that owes its origin and continuance to disease, a bad condition of the blood, or a too feeble propulsion of the blood. The effect of impeded capillary circulation is, that these porous and tissue-feeding vessels come to excrete an excessive amount of fluid, and that their powers of absorption are overtaxed. This is especially the case in those epithelial glandular cells that line the capillaries, of which cells, as well as of the many other kinds of cells which make up our body, you have pictures in your small text-books on physiology. Then, owing to this capillary stagnation and the consequent inefficient working of the capillaries, the blood no longer carries enough or sufficiently vitalizing nutrition to the organs and tissues, thus causing either an imperfect or an abnormal exercise of their special functions. Such a state may arise whenever there is obstruction to the free circulation of the blood, in the heart, lungs, liver, or kidneys, or as the result of insufficient oxygenation of the blood by the lungs. Acids, after their characteristic manner, and all substances acting like acids, tend to develop dropsy owing to an abnormal permeability which they create in the capillaries that allows of their giving off an undue amount of the watery part of the blood they carry, such as they would under the pressure of stasis.

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* This name properly speaking should be used only when the bursa of the knee-cap is involved, constituting a "bursitis."

You will more easily understand how all this comes to pass if you recall what you learnt of the structure of the heart and of the three kinds of blood-vessels—the arteries, proceeding from the heart; the veins, proceeding to the heart; and the connecting capillaries, in which minute and porous vessels goes on that ceaseless interchange between the elements of the blood they carry and those of their surrounding tissues, an interchange equivalent to that which goes on between the air-cells and the blood-vessels of the lungs, and which is equally essential to the life of the body. As terminal parts of the arteries the capillaries give off oxygen and other tissue-feeding materials which their elaborating cells secrete from the blood, and as the commencing parts of veins, it lies with them to collect and absorb the waste products of the labouring muscular tissues—mainly carbonic acid gas—to be conveyed by the veins to the heart and thence to the lungs, there to be got rid of in respiration. Bearing these facts in mind, try to realize how much of the work of reviving and cleansing the body is carried on in what are perhaps its minutest parts, namely the epithelial lining cells of the capillaries, and how all-important to health is their ability to do their work well, otherwise all the cells which make up the body will be ill fed, and will therefore degenerate and only imperfectly reproduce cells for cells in their original likeness.

The force and pace of the blood through the capillaries depend on the propelling power of the heart, and necessarily both at all times are much less in the capillaries than in the larger arteries. Just as the rapidity of a current lessens when, no longer confined between enclosing banks, it widens out over shallows, or its waters are divided by sandbanks, so the force of the blood-current decreases as it is distributed throughout networks of minute capillaries, vessels that in themselves offer a certain amount of resistance to its passage. But should this natural, and as regards the feeding of the tissues, favourable pace, be reduced owing to the feeble propelling action of the heart, or locally owing to the stasis of congestions, then the pressure of accumulating blood will force out of the capillaries a more than normal exudation, more than the tissues can absorb or the lymphatics perhaps can remove. If, along with the evil results of stasis, there is present in the blood some poison or element injurious to the epithelial glandular cells of the capillaries, it may well be that these cells will gradually become incapable of carrying out their work of secretion and absorption. In such circumstances the blood which the heart receives would necessarily become less and less fitted to maintain the contractile and propelling powers of that organ, till finally this vicious circle will cause dropsy. And surely we cannot wonder that dropsy should distend the skin, or swamp the intestines, and at last drown out life in its disintegrated stronghold, the heart, when the work of maintaining the cells of the body is so inefficiently carried on, seeing that the cells themselves have been rendered mechanically and chemically inefficient up to the point of, in some parts, only producing abortive offsprings.

It is perhaps when there is some very pronounced functional failure, as in nephritis (inflammation of the kidneys), that dropsy most surely ensues, sometimes with amazing rapidity, for in this disease, commonly known as Bright's disease, the deteriorating and damaged renal tubes fail not only in their work of carrying off water, but in eliminating the more solid waste-products of the body, with consequent contamination of the blood. How powerful that contamination is in uræmia, with its complete, or well-nigh complete, suppression of the urine, is sometimes all too plainly evidenced by coma, or maniacal delirium, or epileptic-like seizures that herald a fatal termination. The leading cause of such a functional failure in fatal or progressive attacks of Bright's disease, is brought to light when microscopic examinations of the sediment of evacuated urine are made. They reveal, besides albumin, various tubular casts, some with fatty contents, telling of fatty degeneration; also epithelial gland cells, either entire or in shreds, the loss of which leaves the denuded tubes incapable of performing the work of secretion and excretion.

The evil effects of nephritis following on an ill-developed and too lightly treated attack of scarlet fever (the first startling intimation of mischief to the unsuspecting sufferer being perhaps blood in the urine—hæmaturia) may be greater than in nephritis due to a chill-induced inflammation, for in the former the blood of the patient is doubly poison-charged, there being the poison of the non-eliminated waste products and that of the fever. Such, too, is more or less the case when intemperance is the cause of nephritis, the poison of alcohol being then added. Ascites, too, very often results from constant dram-drinking, or from dram-drinking on an empty stomach, a far more injurious habit than spirit-drinking at meals, or with milk. In such a case almost no wholesome food is consumed after a time, or what is eaten cannot be digested, and the stomach, to which the spirit passes directly, soon becomes irritated, and the flow of the gastric juices arrested. Hence indigestion! If the pernicious habit be persisted in, blocking of the finer blood-vessels in the intestines ensues, creating obstruction to the circulation of the blood throughout the portal system, together with engorgement of the liver, due to the lymph laid down by inflammation. Before long follows the life-imperilling stage, the shrinking and hardening of the liver, a condition popularly known as "hob-nail liver," by which time, if not earlier, the abdominal cavities have become distended with the water of dropsy, while the diaphragm, which consequently had been pressed upwards, painfully interferes with the movements of the heart and lungs. The close of the chapter cannot then be far off. But though drinking is often the cause of ascites, I pray you not to conclude that all sufferers from ascites are intemperate, for many troubles culminate in abdominal dropsy, such as peritonitis (inflammation of the delicate covering of the intestines), tumours, and malignant growths in the liver, and ascites has its part in the general dropsies that come of nephritis or of heart disease.

Whether your work lies in hospital wards or in private practice, you will find what a high percentage of dropsical patients suffer from some heart or renal disease, or not uncommonly from both. Of the different forms of heart disease which may lead to dropsy, the most frequent are those of valves which bear traces of the fiery passage of a rheumatic fever which may have raised obstructions to the passage of the blood through the heart, or left gaps for the blood to eddy in, with a consequent serious weakening and slowing of the blood-current. Any disabled valve must inevitably detract from the power of the heart to rule the circulation of the blood. Should, however, a valvular imperfection happen to be a mitral one, there is little probability of dropsy developing, provided the lesion is not progressive nor degenerative in character. In mitral difficulties, Nature often provides a compensating force wherewith to overcome the obstruction which thickened edges cause, by a strengthening hypertrophy of the left wall of the heart. This organ can then not only master the valvular obstruction, but propel the blood through the arterial blood-vessels with more than normal force. Against this victory, however, the chance of this added force proving dangerous has to be reckoned with, especially in old age, when the blood-vessels are less elastic. In some cases danger signals are not lacking, such as unlooked-for bleedings from the nose, or patches of extravasated blood, not to speak of a hard pulse not easily compressed, that foretell a final catastrophe in the bursting of a cerebral vessel, which means a paralysing apoplexy. A like danger lies in the high blood-tension of Bright's disease, the not infrequent signs of which are the bursting of blood-vessels on the eye or a blinding inflammation of the retina.

Altogether different is it as regards ensuing dropsy, if, as not infrequently happens in repeated rheumatic fevers, it is combined with aortic regurgitation or mitral imperfection, which condition, as it allows of a backward return of blood into the chamber from which it had been expelled owing to imperfect closing of the aortic valve, causes overcrowding and delay in contraction of the left ventricle. In bad examples of this compound form of valvular disease, the tax such incapacitating defects inflict on the propelling power of the heart is great, so much so that little of its force reaches the capillaries or veins; hence retarded venous return, congested organs, and an excessive exudation of serum from the capillaries. How far such a condition may go, and the rate at which dropsy may develop, greatly depend on whether the sufferer can or is willing to adopt the form of life that entails least strain on the heart. In some cases a strictly maintained recumbent position offers the only chance of life.

But inevitably, in spite of the best care, sooner or later cellular degeneration sets in more or less throughout the body, and the cells fail in their perfect reproduction, in consequence of which other important organs in their turn cease to fulfil efficiently their special functions, thus greatly increasing the original evil. It may be the kidneys can no longer eliminate the poisoning waste products of the body. More often, however, the liver—that largest gland of the body, so richly supplied with blood in its double network of capillaries, and which when sound acts the part of a guardian to the blood by protecting it from deleterious products of incomplete processes of digestion—fails, owing to the hampered condition of the capillaries, in some of its manifold functions, such as the elaboration and secretion of bile, or the converting and reconverting of sugar, and its storage till required. As fibres of the heart are degenerating at the same time, there is no chance of a saving hypertrophy developing, but on the contrary every certainty of an increased dilatation of the chambers of the right half of the heart, with possible failure in its tricuspid valve, and with a corresponding weakness in their contractions — so needed to expel the venous blood with which they are overcharged into the lungs. If along with the impeded passage of blood into the heart from the lungs owing to mitral and aortic obstructions, the blood is feebly propelled by the heart into the lungs, they will become steadily more and more engorged, and the circulating force of the blood will be lessened to such an extent that a fatally advancing dropsy is inevitable. It may be, however, that this very engorgement of the lungs, were a chill or some other cause to start a bronchitis or congestion of the lungs, might save the patient from protracted suffering; or, happier still, a long-dreaded syncope, of which there is always a risk in aortic valvular disease, may bring sudden death.

The cellular condition resulting from cardiac or renal disease, or other pathological causes, when the cells become over-saturated with serum and under-supplied with life-giving materials, seems to me analogous to what takes place in plants when the soil from which they draw their nourishment is flooded and remains marshy. Then, as you know, they will become mouldy and unable to bring forth good seed.

Dropsy resulting from nephritis unassociated with any form of heart disease, usually first shows itself in the face and possibly on the backs of the hands, whereas cardiac dropsy most commonly starts in the extremities, especially in the lower as farthest from the heart, and there water may collect to such an amount that the skin bursts. Truly pitiable is the state of such sufferers, but to-day there is not time to speak about this final stage of cardiac disease, nor about its earlier features and ominous symptoms, nor, on the other hand, of how the dropsy of a not too far advanced nephritis can be arrested. Fuller particulars must be left to other lectures. When describing the diseases that tend to produce dropsy, I have purposely spoken only of the worst examples, and of so much of their course and symptoms as offer obvious explanations of the advent and fatal advance of dropsy, and how, on deliberate transgression of the laws of bodily health, it comes as the executioner of a death sentence.

SUBJECT XI

SLEEP AND SLEEPLESSNESS (INSOMNIA)

LECTURE I

THEORIES CONCERNING SLEEP—SOME SIMPLE MEANS OF PROMOTING SLEEP

To the repose of the brain and the general state of relaxation throughout the body associated with it, we usually apply the word sleep. By using a special term instead of the more general one of repose or unconscious rest, we accustom ourselves to look upon sleep as a special manifestation rather than what it is, namely, merely the conformity of the brain to the universal law of alternating work and repose, binding on all organs of the body. It is true that the brain conforms to this law after its own fashion and at its own times, and while doing so it enforces, by right of its rank as a commanding officer, more or less conformity with itself on its obedient subordinates, who not only have to dance to its fiddling, but to rest when it rests. Further, seeing that, by reason of its ruling position, the brain cannot afford to take intervals of repose at pleasure like some of the muscles, nor frequently like the heart and lungs, it must of necessity have proportionately long periods of repose, that is, sleep.

Let men call it what they choose—rest, repose, or exhaustion of the automatic activity of the brain; and let them try their best to explain the inducing causes; sleep will yet remain a puzzle to physiologists, and a blessed marvel to excite our daily thankfulness.

What immediately concerns us as nurses is to find out as far as we can, theoretically and practically, which are the conditions most conducive to sleep, and which prejudicial to it. Doctors have at command numerous wonderful narcotics, but there are many useful sleep-inducing expedients open to an intelligent nurse, which when efficacious are much to be preferred to narcotics. It is about these I propose to speak to-day, addressing myself more particularly to those of you who are soon to begin private work, perhaps where a doctor is not to be had easily.

Let us first look at the theoretical side of our subject, as a help in selecting sleep-inducing expedients, and also to help us to understand better what is the principle doctors follow in their choice of narcotics. What we have to consider is : What, so far as we know, are the conditions that produce sleep ? Or, to put it another way : What is the condition of the brain in sleep ? Once that condition is ascertained, all endeavours to promote sleep will naturally be directed towards establishing it, or to combating opposing influences.

As a result of the many and protracted controversies between physiologists on this subject, two points practically are established : one, that the brain receives a diminished supply of blood in sleep as compared with the supply in waking hours ; the other, that sleep follows on brain exhaustion, unless some opposing force intervenes. To many investigators these almost obvious theories did not afford a sufficiently satisfactory explanation of that common sensation, "feeling so sleepy," nor of the spontaneous awaking to complete consciousness and full mental activity after a certain period of sleep. Hence arose the further theory, that the brain and nerves are acted upon by two inbred substances, differing in their properties and in their effects on the brain, the one being evolved during sleep, the other during the hours of wakefulness and activity ; the former possibly secreted systematically by some gland, the latter merely the residue of tissue waste products, which in certain combinations might engender sleep. Both in England and abroad this theory has been widely discussed and experimentally tested, with the result that several distinguished writers have accepted it as at least a part explanation of the phenomena in question—periodic sleep, with its spontaneous return to wakefulness. Doctor Bouchard, an eminent French physician who died only this year (1913), wrote many years ago in his work on "Auto-intoxication in Disease," that during the day the body forms a substance which, when it has accumulated, induces sleep, and that during sleep it elaborates a convulsive instead of a narcotic substance, which when it has accumulated will produce muscular twitchings, and thus lead to awaking from sleep. Again, Dr. Bouchard says, the urines of the day differ from those of sleep not only in their greater toxicity but in the character of their toxicities, those of sleep being strongly convulsive, those of the day distinctly soporific, and little or not at all convulsive. Later, Sir Lauder Brunton wrote very much to the same effect : "There seems to be a sort of self-regulating mechanism of the body by which sleeping and waking are made to alternate. During waking hours, soporific products are formed, which, accumulating in a certain number of hours, will by and by induce sleep, while during sleep stimulating ones are being formed which will stimulate the brain into wakefulness."

Finally, this year the results of experiments by Doctors Legendre and Peiron strongly support the statements of these two writers. Dogs were kept awake over a considerable period, and others in a normal condition were injected with a substance which had been detected in the blood and cerebro-spinal fluid of the wakeful dogs. The effect on the injected dogs was to provoke an irresistible tendency to sleep.

As to whether any special gland or glands of the body do or do not secrete substances conducive to sleep, recent researches into the causes of "sleeping sickness" have once more raised that question, and some investigators have gone so far as to credit the "pituitary body," which lies in a deep depression in the upper surface of the sphenoid bone, near the root of the nose, with this property, on the ground that in cases of "sleeping sickness" that gland has been found highly hypertrophied, and that when certain intoxicant drugs were experimentally used, over-secretion of the pituitary body could always be induced.

Let us now turn our attention to the generally accepted theory that sleep is promoted and maintained when the supply of blood circulating in the brain cells is a diminished one, or, to put it more shortly, that sleep is dependent on an anæmic state of the brain. The better to impress this theory on our minds, let us consider some of the proofs already established, and look for yet others to be found in support of this theory. Then, with this knowledge as our guiding principle, let us see how best to procure sleep for our patients. But I would not have you think that our simple expedients can be of use where there is pain or fever, nor even in cases of excitement caused by shocks or by mental worry. For these, narcotics are required, for they only can bring that "sleep and much forgetfulness of things" so essential to the quieting of the nerves and brain.

We will first take the well-known experiments of Durham and Jackson. The former removed a circular piece of bone from the skull of a dog, along with a piece of the dura (the outermost of the three coverings of the brain), and replaced them with a watch-glass, thus allowing the surface blood-vessels of the brain to be seen. The difference of their appearance in waking and sleeping was marked, the tissues being pale and contracted in the latter state. Jackson, by examining with an ophthalmoscope the blood-vessels of the retina in sleeping children, satisfied himself that these vessels were more congested in sleep than in wakefulness. In this I think we see the explanation of that common spectacle of a sleepy child rubbing its eyes till a compassionate nurse or fond mother says to it, "Little people with sand in their eyes ought to go to bed," and carries it off on her shoulder, soon to be asleep in its cot. Evidently in such a child, congestion of the blood-vessels of the eyes has already set in, causing the sensation of sand in the eyes.

I think we may easily find simple proofs for ourselves in some of the daily occurrences of life, which call only for intelligent observation rather than for much learning. Most people know that during sleep, and on awakening after long hours of sleep, the pulse is commonly weaker and slower and the temperature of the body somewhat lower, than during wakefulness. This explains in part why people are more readily chilled when asleep than when awake. Another proof that leads to the same conclusion is one to which you can probably testify from personal experience, namely, that boots sufficiently easy in the daytime, if worn during hours of sleep cease to be so, the feet having swollen owing to a lowered circulation which leaves the blood to stagnate in them, even though they may be raised. You probably are aware that extreme cold induces sleepiness, and have heard of how men caught in snowstorms, on lying down exhausted in the snow, have fallen into a sleep from which they never awoke; but it is not so well known that chilliness in the abdominal wall, on the contrary, induces wakefulness, because the contraction thus excited in the internal blood-vessels sets an extra amount of blood free to go to the brain, and thus produces an effect the opposite to that which follows from the presence of food in the stomach, because it attracts blood from the brain. On the matter of maintaining warmth on the abdominal surface, we might learn a lesson from our four-footed friend, the dog, who when he means really to settle to sleep, carefully curls himself up, so as to give his abdomen the benefit of the warmth of his limbs.

There is a treatment said to have a calming and soporific effect, which has sometimes been practised on wildly delirious or excited insane persons, namely, compressing the carotid arteries, with a view to delaying the passage of the blood into the brain. This, however, you must never attempt, for it requires a special instrument, neatness of hand, and far greater geographical knowledge of the throat than you possess, to avoid pressing the jugular veins or the pneumogastric nerve, which, as it regulates the actions of the heart and the respiratory organs, if compressed might result either in fatal syncope or in convulsions.

So much for the amount of blood in the brain in sleep, but how about its quality? We all know how the quality of the air we breathe affects us, or rather how the air acting on our blood affects us. If we sit long in crowded rooms, their greatly diminished supply of oxygen and excess of carbonic acid gas cause drowsiness. May it not well be, that by the end of the day our elaborating and eliminating organs become so exhausted that their work gets ahead of them, thus allowing some of the waste products to remain, the effect of which answers to that of bad air ? Undoubtedly there are elements in the blood, bred of disease or of badly working organs, which may have a soporific influence, but for the most part bad-blood elements are inimical to sleep. Sufferers from gout are poor sleepers, pain apart, by reason of certain toxic substances absorbed into the blood from the large intestine. Bilious persons, and persons with congestion of the liver, also suffer from insomnia. The best chance for such lies in the doctor overcoming the exciting cause, for narcotics are little advisable for bilious persons.

Another most important factor on which sleep and sleeplessness turn, is the condition of the arteries. A curious proof of this is that some persons will fall asleep standing, while on assuming a horizontal position they become wakeful. The explanation is that their arteries are so relaxed that the blood slips through them without opposition, while a horizontal position goes to retain the blood in the brain, and so to stimulate it. On the other hand, persons with hard pulses, that is, whose arteries are distended by blood, as in Bright's disease, are often bad sleepers. With such, the distention is not due to any extra amount of blood throughout the body generally, but to the resistance which the contraction of the arterioles and capillaries creates to its passage into the veins.

Insomnia not infrequently is one of the trials of old age, the cause of which is thought to be the lessened power of the finer cerebral blood-vessels to contract, a condition however not so serious as regards intelligence and life as when deteriorated vessels become incapable of bringing sufficient reviving blood to the brain, for that means mental failure.

We now come to the treatment of such cases of sleeplessness as might be amenable to simple expedients. In conformity with the theories of which I have spoken, and as backed by every-day experiences, I may recommend the following :—

If the weather is cold, see that your patient is more warmly clad for sleep, more especially in the small hours, than when awake, and if he is chilly, apply a warm bottle to the abdomen for a short time, directing him to put his hands on it, for this will draw the blood from the brain. After some hours of fasting wakefulness, a small allowance of light food will often produce sleep by attracting blood from the brain into the stomach, because the processes of digestion necessitate an increase of blood in the blood-vessels of the stomach to supply the secreting gastric cells with material out of which to elaborate the gastric juices necessary to digestion.

If the head is hot, the application of evaporating cold cloths is a helpful means.

Should a patient be suffering from congestion of the liver—a fruitful cause of sleeplessness—put the feet into hot water—always supposing he is in a condition which allows of it—to which has been added a tablespoonful of mustard. With congested livers, and in sleeplessness from high arterial tension, a mercurial aperient assists, for, apart from its later aperient action, it acts as a narcotic; but for anyone requiring the services of a nurse, this measure is one for the doctor to direct. A simpler and safer expedient, less well known in England than abroad, is from a teaspoonful to a teaspoonful and a half of orange-flower water the last thing at night in a wineglass of warm water, with sugar if desired. Sir James Simpson used to say of it, " We do not know what is in it, but certainly sometimes it succeeds where well-known narcotics have failed."

Those of you who have lived in country districts must be acquainted with various homely remedies not to be despised. Onion broth, or a stewed onion, or lettuce are helpful; while the French peasant believes in eating a roast apple in the evening to bring sleep. When an attack of indigestion or of distending flatulence adds to the other troubles of a patient, relief is to be had from three or four drops of essence of peppermint in hot water, or if that is not procurable, from strong peppermint lozenges, but the former is preferable because hot water promotes sleep. Four or five drops of oil of cajeput on a piece of sugar has the same merit, and so has nutmeg and clove tea, or camomile tea, though with some people this last drives away sleep. These remedies, mild as they are, are inadmissible in typhoid fever or gastric ulcer. You know how strictly limited to milk or beef-tea are typhoid patients, and how dangerous is any transgression of this diet, but perhaps some of you are not aware that in gastric ulcers, often no food by the mouth is permitted for some time. A useful, and in all cases harmless, measure, is to pour a few drops of spirits of camphor on a cloth and hold it near the patient's nose, or a piece of camphor held in the hand, which many would prefer to a hop pillow on account of its unpleasant smell. Then there are two expedients of a different kind, which may bring sleep to some: rubbing the arm lightly with eau de Cologne or lavender water, or combing the hair gently for about a quarter of an hour, though these cannot be resorted to if the patient dislikes being touched or handled. A certain form of massage, done down the spine, hand above hand with a downward movement, is soothing to some nervous persons, but the reverse with others.

Above all things, if you wish to give your patients every chance of sleeping, see carefully to the bed. Find out if there is anything, either in the mattress, pillows, or bedding, that would prevent perfect relaxation of every muscle of the body, for any effort on the patient's part to keep from slipping down or to avoid pressure on some part of the body, means muscular contractions, and consequently work for the directing brain. Small pillows, or failing them, rolled-up towels, if judiciously used, will do much to remove a sleep-destroying strain, and at times may answer better than an alteration in the bed, for they can be changed at any moment and moved about according to the patient's requirements. But in this matter, as in many others, do not seek to force what you think best against the will of a patient, for by so doing you may make him think that to have a nurse is an evil. If it is a true saying that "A fool knows more about his own affairs than does the wisest man," still more true is it that a suffering person knows best what relieves him and what does not.

SUBJECT XII

UNCONSCIOUSNESS

LECTURE I

SOME OF THE CAUSES WHICH INDUCE UNCONSCIOUSNESS

I INTEND to speak to you to-day not about any one malady, but on a wider subject, namely, the unconscious state—a state which when quite complete in sick persons or persons injured by an accident, forcibly suggests the sleep of death, of which in truth it is often the forerunner, but which has in profound sleepers or anæsthetized persons a very different significance. In the consideration of this subject I wish mainly to point out how certain causes directly or indirectly affect the brain to the producing of unconsciousness, and to the outward signs which in some cases of unconsciousness serve to indicate its cause. I shall try to make all this plain as I pass from example to example of differently created unconsciousness. This subject can scarcely fail to interest you, for surely no intelligent nurse, brought face to face with an unconscious person of whose history she knows nothing, but would wish to have some understanding or explanation of what had brought about a condition so closely resembling "death in life." If the patient is being treated in his own home, the difficulty in arriving at a conclusion regarding the cause of unconsciousness need not be great if the nurse is thoroughly instructed as to the nature and the dangers her patient's illness involves. Yet, even then, some complicating, unsuspected trouble might suddenly result in unconsciousness, of which the recognized malady did not supply the true explanation.

I touched on the subject when I spoke to you about sleep and sleeplessness, but then we were mainly occupied with the consideration of the conditions adverse and favourable to procuring sleep, rather than with the unconscious state of the sleeper—for surely a sound sleeper may fairly be said to be unconscious? In a sleeper it seems as if the mental nerve centres—those complicated and many-fibred neurons that crowd the uppermost layer of the cortex of both cerebral hemispheres—had had their connections turned off, for the time being, with the motor and sensory nerve centres lower down in the cortex, and with all the other centres with which they ordinarily intercommunicate throughout the rest of the brain, and that they merely lay silently occupied with drawing nutrition and restoration of their tired powers out of the somewhat diminished blood-supply of sleeping hours. While, on the contrary, the nerve centres which have their seat in the base of the brain, in the medulla oblongata, and which rule the heart, lungs, blood-vessels, and all the organs which work for the renewal and cleansing of the body, never cease from their labours. Thus the health and the wits of him "who slumbering lies" are maintained in full perfection. Even the work of the latter is carried on a little less vigorously than during waking hours, of which fact there are proofs in the slightly lower temperature and the somewhat slower pulse—two symptoms which so commonly accompany sleep that they might be regarded as the signs of an unconsciousness not caused by disease or by a brain injury, but which on the contrary give promise of a renewed and brightened consciousness.

I will not detain you by speaking of the unconsciousness in which fatal illnesses so commonly terminate that wonder is expressed if in such circumstances consciousness survives up to the moment of death. It speaks as plainly for itself as does the falling over of the wick of a candle when the sustaining wax is melted; but as I have touched on this condition, I would like to give you a word of warning against speaking within ordinary hearing distance of a person you deem unconscious; for it has happened that persons apparently unconscious had retained their powers of hearing. I will mention a case in point which may help you to remember my warning, and, seeing how much that is sad attaches to our subject, I am glad to say this story is not a sad one.

When a guest at K. F., the early home of a certain Miss Elizabeth N——, or, as she was more usually called, Mistress Elizabeth N——, I learnt that lady's history and the following incident from the then owner of K. F., a collateral descendant of the said Elizabeth N——, who, on the death of her only brother, became the possessor of K. F., and later, from want of nearer heirs, of several other properties, the largest and finest of which was in Yorkshire, where she lived during the greater part of her life. She would listen to no suitors, for being very far from good-looking, as her portrait which I saw at K. F. showed, she was fully convinced that it was only on account of her wealth that she was noticed and made love to. Not very long before her death, for the first time in her life she had a dangerous sickness, and was so feeble that to all appearances she was insensible. Her kinsfolk hastened to her bedside, and talked amongst themselves of what arrangements for the disposal of her properties she might have made, and of their individual hopes and fears, with no idea that this tough old lady was still capable of hearing. To the amazement of all concerned she recovered, and greater still was the amazement of her kinsfolk when shortly afterwards she summoned them and told them she had heard all they said, and that to save them further speculation she would let them know how her will stood. It was a simple one, for she had arranged that her different properties should return into the families from which she had derived them. Some, no doubt, were pleased and others disappointed, but all left her presence somewhat shamefaced, not however before she had further told them that when she died she hoped there would be no gathering of county magnates at her funeral, but on the contrary that her body might be carried by her tenants by torchlight to K. F., and there buried beside her mother. That her wish was carried out I learnt, for when happening one day to be in the grounds of the beautiful place where she died, I asked an old labourer whom I saw sweeping up dead leaves, if he had known Mistress Elizabeth N—. He answered, " Oh, yes," and proudly added, " I was one of those who with a torch carried her coffin to K. F."

Of the numerous causes of unconsciousness, I have chosen the following well-known ones : syncopes, epileptic fits, asphyxia, powerful anæsthetics, opium and alcohol in life-endangering quantities, the coma of uræmia and of diabetes, and finally concussion and compression of the brain, including pressure on the brain from self-developed causes.

The syncopes which produce complete unconsciousness, and are the most likely to prove fatal, are those occurring in persons suffering from pronounced valvular diseases, especially if aortic, or from fatty degeneration of the heart. With cardiac syncopes—as these are usually called—the brain suffers from the shock it receives through that suddenly diminished blood-pressure which results when the heart, for ever so short an interval, ceases to expel its wonted quota of blood; or when an overtaxed degenerated heart delays the course of the blood-circulation by failing to contract sufficiently ; or when a violent hæmorrhage deprives the brain of its customary share of blood. We have only to remember how sensitive and delicate are the structures of the brain, and to regard its blood-vessels and the blood which fills them, not only as the sources of its nutrition but as the protective padding, so to speak, which supports it and saves it from jars and displacing disturbances, to realize why this should be so. One might as well expect that soft ripe fruit would travel uninjured if packed without sufficient elastic padding, as that the brain should not suffer when deprived of its protecting amount of padding.

In the unconsciousness of epileptic fits, the brain itself is the direct cause, for in persons so affected there is a strange instability in the nervous system which shows itself in sudden "brain storms" with their uncalled-for nerve discharges, often uncontrolled or not counterbalanced for the moment by opposing inhibitory nerve centres. When these sudden nerve storms discharge themselves mainly on the motor nerve centres in the cortex, epileptic fits then assume their characteristic feature of epilepsy, namely, those convulsive muscular contractions which so hideously distort the unhappy sufferer and fill an unaccustomed spectator with terror and horror. In the milder type of epileptic fit, which results only in a sudden fall into and a quick recovery out of a short unconsciousness, unmarked by more than a passing bewilderment, a casual observer, unacquainted with the history of the case, might think that this unconsciousness was that of an ordinary fainting-fit. But even in these modified (minor) fits there are points which mark the difference between them and syncopes, for persons about to faint usually turn pale and are aware that a syncope threatens, and recovery is slow and laboured; whereas with epileptic fits, as a rule there is no pallor, at least not to start with, nor any sense of faintness (let other premonitory warnings—the so-called "auras"—be what they may), for in epilepsy the heart is not affected, unless during a fit it is made to suffer by the pressure of strong muscular convulsive contractions. Another peculiarity well known to all who have had to do with epileptic subjects, is the protracted sleep into which they fall after a fit, a symptom that suggests that the exhaustion caused by these brain-storms may be somewhat analogous to that "sleepy stage" common in persons recovering from a concussion of the brain. But the saddest peculiarity of epileptic fits, whether minor or major, is that the sudden discharges of grey brain matter which take place unprovoked by any normal stimulant, once started go on repeating themselves—just as does any desirable brain self-perpetuating habit—and in consequence cures are few.

Though I intended this lecture should be purely explanatory rather than practical, I cannot refrain, before we leave the subject of syncopes, from telling you how to safeguard your patients, especially those with heart troubles, from fainting, or if they faint, what to do and what *not* to do. To begin with, always bear in mind that when such patients suddenly assume an upright position after having lain for a long time flat in bed, there is risk of a syncope, as also when there is over-distention of the stomach, because this may force the heart out of its normal position. No doubt you are aware that when a hæmorrhage causes considerable loss of blood, fainting is probable, but perhaps you do not know that, or do not understand why, a simultaneous sudden emptying of a full bladder and of the bowels may also cause fainting in the sickly. The explanation is, that when the outside pressure on the abdominal blood-vessels which the distended bladder and bowels caused is removed, the released arteries become lax, and the veins dilate, so that more than the ordinary amount of blood passes into them with greater ease, at the expense of the brain. Surgeons so well know the results of a suddenly diminished pressure on the abdominal vessels that when they tap a dropsical person they make use of a bandage round the body, so arranged as to allow of its being tightened in proportion to the amount of water removed from the abdomen. Thus fainting is prevented by guarding against the effects of suddenly lessened pressure on the blood-vessels, and at the same time the brain and heart are saved from being robbed of their proper quota of blood.

When persons faint in crowded halls, of course the one thing to be done is to get them as fast as possible into the open air ; but with the syncopes of cardiac cases, especially if complicated by a hæmorrhage, it is essential to lay such persons flat, or, if already in bed, to hang their heads over the edge of the bed, so as to make the blood flow brainward, and to stimulate the patient by strong smelling salts, etc. With hæmorrhages you ought to be careful how you give stimulants, for they excite the heart, and its reinforced action might bring a return of bleeding, whereas weakness of the heart is in favour of the broken blood-vessel closing up. Too many people, when they see a fainting person fall to the ground, rush in hot haste to raise him, than which nothing can be more unwise. If any proof were needed of the possible effect on the blood and brain of a human subject raised from the ground into a perfectly upright position, we have it in the practice of French surgeons before the days of anæsthetics, when they wished to induce unconsciousness before operating. The patient was laid flat on the floor, and after an interval of time, by the aid of several stalwart men he was jerked perfectly upright as quickly as possible. This manœuvre brought about the desired result.* You will find it easier to understand what you read or hear on this subject, if you bear in mind that in the human body there is not enough blood to fill equally all the parts at the same time. We are not like bran-filled dolls, nor like milk bottles so entirely filled that the milk cannot be shaken about. Were we so, our hearts could not act, nor would our bodies gain the good they do from a free circulation of the blood and from its changing in amount in different parts, such as the increased supply of blood that goes to the stomach to help digestion, or the diminished amount in the brain during sleep.

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* "Circulation and Respiration," by Sir Lauder Brunton, p. 403.

One more word of warning on a somewhat different score. Never allow bad news to be given suddenly to your patients, for, as Huxley says, "Men and women often faint and die because, in emotions, the perturbations of the brain give rise to a something which arrests the heart as dead as you stop a stop-watch with a spring." In this, what I might call a dramatic syncope, we have the order of the exciting factors reversed; for here the brain acts on the heart, and not as in cardiac syncopes the heart on the brain.

Asphyxia.

In asphyxia, the cause of unconsciousness is quite different from the causes that give rise to syncopes or to epileptic fits. Asphyxia is the term applied to the condition which follows on a total cessation of respiration, however brought about, and which affords so striking an example of the unconsciousness and the too often fatal results which follow as the effects of unoxygenated blood on the brain. It is not the throat-closing pressure of a strangling hand, nor the choking action of some obstacle swallowed, nor the water in which a drowning man is submerged, nor the poisonous gas inhaled, which actually causes asphyxia. What does so is the unoxygenated state of the blood which any of these conditions creates, and which fatally affects the brain, as evidenced in the desperate respiratory efforts and muscular cramps that come of over-excitement of the nerve centres in the medulla, centres which in health regulate the action of the heart and lungs. The livid colour of an asphyxiated person's face shows how his blood has changed, and if nothing is done to improve the blood, unconsciousness and death soon follow, the nerve centres having finally become paralysed.

Asphyxia is certain to result from exposure to the gas which sometimes collects in cellars, as well as in mines and lime-kilns, and which after mine explosions, as "choke damp," has so felling a power. Fatal, too, may prove the breathing of air heavily charged either with coal gas or with the fumes of charcoal, for both give off carbonic oxide, which so acts on the corpuscles of the blood that they soon become incapable of absorbing oxygen. As a rule, with sensitive persons who faint in crowded meeting-places, being carried into the outer air suffices to bring recovery; but it is different if, owing to some unforeseen circumstance, an undue crowd gathers in a building in which there are no means of admitting additional air, and in consequence carbonic acid gas collects to such an extent as to dangerously diminish the amount of oxygen in the air. To re-establish respiration and restore to consciousness persons thus nearly suffocated require more than the open air alone can effect, yet their case may not be so precarious or so surely fatal as that of a person asphyxiated by carbonic oxide, nor so complicated as that of the nearly drowned, chilled as such are, and with their lungs and air-passages choked with water.

Asphyxia may also occur from various internal conditions which deprive the blood of oxygen; for instance, a dislodged clot carried into the heart may there so block the pulmonary artery that the venous blood cannot pass into the lungs sufficiently, if at all, to be there oxygenated; while some consumptive patients, whose lungs are extensively destroyed, can only be kept from collapsing by periodical inhalations of the oxygen their blood so much needs.

ANÆSTHETICS.

You perhaps wondered why in my programme I coupled anæsthetics and asphyxia. My reason is that the anæsthetics on which surgeons and dentists rely to bring about insensibility and unconsciousness, produce these results from their power to reduce the supply of oxygenated blood, or to introduce a substance into the blood which prevents it from oxygenating the tissues; hence, were the effects of anæsthetics uncontrolled or left to continue indefinitely, they as inevitably would produce a fatal asphyxia as any of the asphyxiating causes of which I have spoken. We have all heard of persons who have rashly sought relief from pain through self-administered chloroform, and who in consequence were found dead in bed, and of chloroform as a medium adopted by suicides. But knowledge of the dangerous properties of anæsthetics should not make you nervous as to their use, any more than we would shrink from being electrically treated because the current employed is drawn from the main, and if applied unreduced would give a stunning shock, or perhaps kill. But we know that for long it has been possible to reduce the force of an electric current to safe and desired strengths with perfect accuracy, and, what is more, to have that strength distinctly registered. So with anæsthetics. Of known strength, and administered with carefully constructed inhalers by men competent to recognize the extent of their action on the heart and breathing of the unconscious person, the risks attaching to the use of anæsthetics are small, unless the subject has some pathological peculiarity of which neither the operator nor the anæsthetist is aware.

THE COMAS OF ALCOHOL AND OPIUM.

The deep coma consequent on swallowing at one sitting a very large quantity of alcohol—enough perhaps to have killed some persons offhand—is not unlike that which results from an overdose of some powerful opiate. The explanation is, that though alcohol in small quantities acts as a stimulant, in large quantities it has a contrary effect, such as acting on the nerve centres as a narcotic poison, it tends, as do strong opiates such as morphia, more or less to congest the brain and to paralyse the action of the heart. Both in the coma of alcohol and in the coma of opium, the temperature of the body is low, the face is blue, and the pupils of the eyes are greatly contracted, at least at first; while the breathing becomes stertorous, slowly failing in cases that defy treatment. But opium-produced coma has one ruling symptom, namely, a profuse clammy perspiration. Naturally the treatment demanded is not the same with both, but upon this topic there is not time to enter.

THE COMAS OF DIABETES AND URÆMIA.

Whereas the two comas of which I have just spoken may be present apart from any bad or fatal disease, this is not so in the comas that often mark the closing scenes of death from diabetes or nephritis, for with both of these diseases the blood- and brain-poisoning elements are ones that are self-developed in the course of those two most serious diseases. In nephritis, the blood is poisoned because the congested and damaged state of the kidneys causes the body to become charged with its own waste products, of which in health it is periodically relieved by its natural drains and filters; while in the fully developed uræmia of nephritis, no urine, or next to none, is passed. The effect of this condition on the brain may be made evident either by wild fits of delirium or by a more or less deep coma which eventually passes into death.

Of the morbid processes in diabetes which lead up to a fatal termination either by pneumonia or in coma, there is not as yet any universally accepted explanation, nor is there of the exciting cause of this sad disease. But it is evident that in this disease sugar does not serve as a nourishing substance, but on the contrary becomes a poisonous one—because not being used up by the tissues before it reach the kidneys as sugar—with which in severe cases the urine becomes heavily charged. The strength of the poison is shown not only by the excessive amount of sugar passed in the urine of typical cases of diabetes, and by the extreme thirst and hunger from which these patients suffer ; but also by boils and carbuncles and many other distressing symptoms, such as damaged eyes and skin ; also in some cases by violent lancinating pains throughout the body, and finally by comas, with their peculiar gasping type of breathing fitly described as "air-hunger breathing." The odour of the breath of a diabetic patient when lying in a state of coma is that of dried hay or apples, or sometimes of chloroform. This peculiar breathing and the odour of the breath are sometimes all that serve at first to establish the cause of coma in some poverty-stricken unknown casual labourer brought into hospital numb and speechless, and whose gin-soaked garments might otherwise be held to indicate that alcohol was the cause. Probably such a man, whenever he could command enough money, would seek in gin a means to revive his failing strength and to quench the thirst the meaning of which he did not understand. A chill would rapidly develop the last stage of his malady, for nothing more surely has this effect, be it in the poorest of the poor or in the richer and better instructed among diabetic sufferers.

THE UNCONSCIOUSNESS THAT COMES OF CONCUSSION AND OF COMPRESSION OF THE BRAIN.

The damaging effects of a concussion and of compression of the brain, and their probably greater seriousness as compared with the less violent brain disorders resulting from the causes of which up to now I have spoken, might not unfitly be likened to the effects of a sharp fall or a smashing blow on the delicate works of a clock, as against such minor evils as its becoming rusty from lack of oil, or clogged with dust or frozen oil, or being overwound by some reckless hand—minor evils no doubt, but with power none the less to stop the clock and reduce it to silence. In speaking of concussions I do not include those resulting from terrific railway collisions or falling masonry, when the fate of the human victim differs little from that of the teasing fly or the dangerous wasp which we ruthlessly smash by a sharp blow from the first thing at hand, however out of proportion to them in weight, for with such you, as nurses, will never have anything to do. The concussions of which I mean to speak are such as result say from a bicycle fall, or on the floor or street pavement, or from tumbling downstairs and landing on the head, or from a blow on the head purposely given in a street row—all common enough occurrences, and such as you are pretty sure to have to nurse.

When an unconscious man, with a history of a street accident or street row, is brought into hospital, the surgeon has to consider whether his unconsciousness is due solely to a jarring concussion not as yet recovered from, or whether there is besides some brain lesion, perhaps that commonest one, a ruptured blood-vessel, which in time results in brain pressure from the escaping blood. The condition of a man with such a brain lesion is at first so similar to that created by concussion that it is scarcely possible to decide between them; but there can be no doubt of the existence of a brain lesion should a low temperature change into a higher one, or suddenly fall, and above all if there are any one-sided changes in the face or elsewhere. There is a convincing proof of advancing brain compression when the unconscious person having recovered consciousness, after a lucid interval relapses into unconsciousness, but this proof may be lacking if the patient does not recover from the first effects of a concussion before those of compression set in, or if the doctors are unable to ascertain whether there has been a lucid interval between the moment of accident and the time the victim is brought into hospital. Where there is undoubted compression of the brain, only the removal of the cause of the pressure by surgical means can enable the sufferer to recover; even then his chance of life may greatly depend on which part of the brain is affected. This equally applies where pressure on the brain is due not to accidents but to tumours, abscesses, or new growths, from the pressure they create.

SUBJECT XIII

OBSERVATION AND PRECISION

Lecture I

THE VALUE OF OBSERVATION AND PRECISION: HOW TO ACQUIRE THEM

Given to Young Women of the Working-class in Course of Training to become Cottage Nurses

I am not among you to-day to speak about anatomy, physiology, or any of the technical details of nursing, but about certain mental acquirements, valuable in all persons however circumstanced, but especially so in nurses. These are: (1) A correct, quick, and constant exercise of observation; (2) The forming in the mind of a distinct conception of things seen or heard, and the power to express these conceptions clearly and definitely.

As regards means and times for the exercise of observation, it may safely be said that nothing is too common nor any time inappropriate. For example, when walking in the country mark what grows in the fields, the change of one set of wild flowers to another by the roadside, the colour and position of cattle moving or lying down, the varieties in stones or bricks in walls. When you pass a flock of sheep, try to make out how many there are, or if a company of soldiers, note their numbers and distinctive marks. When you enter a room for the first time, try and take in at a glance how the furniture is placed, how the window and door stand to each other, the number of chairs, and whether the chimney shows marks of the fire having smoked. When in attendance on a case, be sure you never fail, on returning to the sick room, to notice how the patient is lying, and what his involuntary movements are: whether his eyes squint, or are turned upwards, or are half closed, or are over-sensitive to light; the colour of his face and lips, and the character of his breathing. It is from much experience among the sick, and this habit of constant observation, that a nurse's opinion as to her patient's condition comes to carry so much weight, as distinguished visiting hospital doctors have told me it does with them. It is by this same habit that conjurors acquire, in part, the marvellous dexterity which is their special characteristic, and by which they are enabled to delude their comparatively half-awake and but feebly observant patrons.

By clearness of conception I mean having clearly imprinted on the mind a definite impression of any one thing or circumstance, complete and distinct in itself—not a mere vague idea attached to some loosely used word. To gain such definite thought, the best way is to set yourself questions to answer, and if in writing, so much the better, for then you will prove in black and white how much or how little you know, and could make plain to others. Begin with easy things. For example—and I purposely select professional subjects—how would you describe dropsy? What is implied by the word fomentations, and for what purpose are they used? What is a "graduated" glass, and what does it look like? If you cannot give satisfactory answers to such questions as these, turn to the "Nurses' Dictionary" and study its short definitions well, and then some days later try whether you can reproduce clearly what you have studied, without the help of the dictionary. Or take home books from the library which give questions on the contents of their chapters, and try and answer them. Another good plan is to take a story you have heard or read, a Bible story if you like—say the story of Joseph and his brethren—and write a short version of it in your own words. Exercises such as these will prepare you to give intelligent, well-expressed reports, and should abolish those hubble-bubble forms of speech, often destructive of truth, or which utterly fail to carry any clear meaning, and which are the despair of anxious listeners. Although your circumstances in life did not admit of your giving years to the study of grammars, foreign or classical, or to science, or to essay-writing, or to taking notes at lectures, not to speak of debating societies, all of which train thought and give ease of expression; still, a habit of close attention will do much towards making amends and will give greater clearness of thought and greater readiness of speech.

Not to everyone is it given to be a very ready or elegant speaker, but where there are clear thinking, thorough knowledge of the subject, and a due respect for grammar, appropriate words will not fail to be forthcoming.

Observation is the head and front of everything, for where a habit of observation does not prevail, inaccurate work is sure to follow. How often are not mistakes, misunderstandings, and unreported changes but the natural results of lack of observation on the part of the worker? Work done by such workers suggests that their eyes, instead of reflecting sharp images, only receive hazy ones, like impressions on the plates of an unfocussed camera, and that their thought-recording pencils are too blunt to leave any legible or enduring marks. With such workers, too, their appreciation of the importance of differences is small, and their sense of responsibility light, till there comes a time when inattention brings about some crowning disaster, such for instance as lately came under public notice, when a nurse administered to a ward patient an ounce instead of the prescribed dram (eight times the prescribed amount) of some opium-containing drug, with the death of the patient as the result. Other disasters, probably known only to the attending surgeon, brought about on the part of a careless nurse, say by insufficient disinfection of a catheter, which thus introduces into the bladder of the luckless patient some of those wicked pus-producing microbes which should have been slaughtered by chemical agents. Or that not uncommon one, an ugly scald inflicted on the insensible limb of an anæsthetized or paralysed patient by the heedless use of an overheated hot-water bottle. Indeed, women afflicted with the malady of "not marking," cannot possibly make reliable nurses, and it were better for themselves and all concerned did they never attempted to fill such an attention-demanding office.

In the navy, disasters occurring through negligence, such as a collision, or a ship running aground owing to insufficient sounding, carry with them for those responsible, bad records, reprimands, loss of certificate, or dismissal. So too in the army, as when a general allows any of his troops to be surrounded by the enemy, or, as in the Russo-Japanese War, when an officer gives orders to open fire on an advancing force, believing it to be the enemy, when it is a detachment of his own troops. In the latter instance where, oh where, were that officer's field-glasses !! and what had happened to the arrangements for keeping up communication between the different parts of the army ? No one, I think, could answer these questions otherwise than by the short word, "Neglect." And I think that disasters in the nursing profession such as those I have mentioned, should rank in like degree of culpability with disasters which come of carelessness on the part of officers in the army or navy, or in engine drivers.

A nurse is much less likely to be answerable for such disasters if she looks upon them in this light, and constitutes herself her severest judge whenever she finds herself guilty of minor shortcomings, such as using or handing to an unsuspecting surgeon a carbolic lotion of full strength when it should have been diluted down to half strength because required for a dressing on some broken surface that was to be left undisturbed for a considerable time; or insufficiently wringing out a fomentation flannel, or too loosely covering it, thereby probably causing, besides a wet nightdress, a chill to the patient, if not an increase of the evil it was intended to diminish.

Believe me when I assure you, speaking as I do from my own experience, and from what I know of the experiences of others, that the more observation and precision of thought and action are practised and sought after, the easier they will become, till they are practically instinctive ; just as a diligent child learning to play the piano soon finds it easy to play the notes of the score without looking at the keyboard. All this of course involves, as does most of a nurse's work, strain and fatigue of mind and body, not conducive to the brilliancy of either. I must warn you too of the risk a nurse runs of losing her natural womanly tenderness when training in a big general hospital with possibly thirty beds in a ward. If she is to be up to time, a given number of beds has to be attended to in so many minutes, and as their occupants are so constantly changed, she may, imperceptibly perhaps to herself, come to regard her patients merely as so many numbers, with no human interest attaching to them. It is, alas! only too true, that some nurses do arrive at such a condition. Only the other day I heard of a nurse, fretful at the vanishing prospect of being free to carry out some purpose by the slow advance of death in her poor hopelessly sick patient, saying : " Oh, Mrs. —— is so slow about her dying." What a slur on our much-vaunted English hospital-trained nurses, who, as regards the professional knowledge acquired by long years in hospital wards, compare so brilliantly with other European nurses.

What is to save a nurse's heart from this sad demoralization, and what is to be her reward, apart from a hardly earned and but small income, for so much labour and fatigue ? Does reward not lie in a realization that she may prove herself an angel of mercy to many sufferers, perhaps to some with little belief in the mercy of God or man. Let her therefore seek by an ever-ready smile and a passing kindly word, if time admits of no more, to prove to such, that at least in her they see a heart full of love and pity. Let her, too, when she sees their sufferings, think of the recorded miracles of healing that God has permitted to be wrought at the hands of men and women alike, and bear in mind how it is written in 1 Cor. xii. 8, 9 : " For to one is given by the Spirit the word of wisdom ; to another the word of knowledge by the same Spirit ; to another faith by the same Spirit ; to another the gifts of healing by the same Spirit," and not conclude that the days of miracles are past and gone. Why, because we are Protestants, should we scout the well-authenticated miracles of healing accorded to ardent believers in Christ's power to save soul and body, which occur yearly at Lourdes, the genuineness of which are most strictly investigated ? I could tell you of some undeniable Lourdes cures, and these not in persons who might be suspected of being mere hysterical or nervous patients.

Always do your best to make your patients take a hopeful view of the means employed for their recovery, and take a pride in being privileged to administer to the sick the healing agents which God's world provides, and on the discovery and study of which much labour and time have been bestowed by man.

Finally, remember that essential as good training and acquired powers of observation and precision are for the proficiency of a nurse, over and above there remain "Faith, hope, charity, these three; but the greatest of these is charity" (1 Cor. xiii. 13).

TWO CHAPTERS OF ACCIDENTS

OR

FIRST-AID IN CASES OF FRACTURES AND OF LOSS OF BLOOD

PREFACE

The author's object in publishing these four very simple lectures is through them to help those young women of the working class who are desirous of gaining "First Aid" Certificates, to answer successfully the questions commonly given in "First Aid" Examination Papers. Such questions for example as, "What is the course of the circulation?" "What is meant by a compound fracture?" In order to ensure the desired result, teachers who make use of these lectures must not fail, while lecturing, to ask questions constantly, nor most patiently to correct unsatisfactory answers. Or, better still, to leave with the pupils after each lecture three or four questions to be answered in writing.

These lectures are limited to setting forth how fractures, and how loss of blood caused by accidents, should be treated when surgical aid cannot be obtained. Even as regards bandaging, any instructions or demonstrations given only go so far as the bandaging needed in cases of emergency. The author found it helpful to supply pupils with several fair-sized dolls for them to practise on between lectures. For this purpose pieces of soft wide tape for straight bandages, old handkerchiefs cut up into triangles, and a good many pieces of strong brown Bristol board in different lengths for splints are all that is required. Teachers, thanks to the use made of these articles, are thus enabled to see how far the pupils have followed or understood the instructions given. Dolls, however, do not do away with the necessity of having a living subject, in the shape of a boy, on whose trousered legs to show how to deal with a broken thigh-bone. And equally necessary, in the author's opinion, is it to have good-sized roller charts, such as show the skeleton and the course of the blood-vessels, along with some of the "First Aid Wall Diagrams"—enlargements of the illustrations in Warwick and Tunstall's excellent book on "First Aid to the Injured and Sick" (published by John Wright & Sons Ltd., Bristol).

H. Hawkins-Dempster.

TWO "CHAPTERS OF ACCIDENTS"

CHAPTER I

FRACTURES

Lecture I

"HANDS OFF"

Before beginning our "Chapters of Accidents," let us have a clear understanding of the meaning of certain terms commonly used in speaking of the human frame. For instance :—

An Organ.—The name applied to any part of the body which has a definite work to perform. Example : the eye is the organ of sight.

A Function.—The special work of any organ. Example : to hear is the function of the ear.

Tissues.—A name given in common to all the substances that go to make up the animal body ; just as when speaking of things used in building, be they lime, iron, wood, or stone, the word "material" is used in common for all. The principal animal tissues are : bony or osseous tissue, muscular tissue, cartilaginous tissue (gristle), fat, and nerve tissue.

Organic Substances.—Those that carry life, and have their origin in life.

Inorganic.—The opposite of organic.

"An Accident."

A crash ; a scream ; a thud. Yonder big ladder has slipped and fallen, and just beyond it on the ground lies a man.

"Have we here a case of broken bones ? " is asked at once. It is only too likely, for the poor man fell from a considerable height, but "hands off ! " Do not move him or "get him up" till it is known *what* is broken, or bad may be made worse. It is not a case of a bleeding wound which requires instant help or change of position. On the contrary, the ground where he lies may be the best place for the man, till well-applied splints and bandages allow of his being removed safely. Is he insensible ? Then, alas ! he may have broken his skull. But even skulls will mend if the brain has not been damaged, and moving him would not be so difficult as if a leg were broken. If the spine is injured, the poor man may be paralysed for life, and lifting him will demand great care. A broken rib would not necessarily be serious: it is only likely to be so if the result of being run over or crushed, for then the point of a broken rib may pierce the lung and cause death by escape of air from it. If the man's rib is broken, he will feel pain at every breath, but by tying a broad bandage firmly round the chest, the pain will be lessened and the rib kept in its proper place, so that he may walk or drive to the surgery. So he may too with a broken arm or collar-bone, if properly supported by pads, splints, and bandages. But when a leg is broken, much harm is done if the patient moves or sympathizing friends move him, before supports and bandages have been applied, and even then he must be carried flat on some form of stretcher.

Mercifully, our patient does not seem insensible, but only stunned, and presently he will be able to tell us where he feels pain, so that we shall not be left to guess the whereabouts of his injuries. He says it is the upper part of a leg which is hurt. Clearly it is broken, for it looks shorter than the sound one, and the foot is turned outwards! What is the best thing to do? In London you cannot do better than fetch the nearest policeman or railway porter, for fortunately they are trained in ambulance classes, and know where to get stretchers, bearers, and all that is necessary. Failing that, send to the nearest surgeon or hospital for help. In the country, trained assistance may not be attainable and a surgeon be far to seek; but unless the conditions of the spot where the injured man fell render it impossible for him to continue lying there, it would be safer to allow him to remain where he is—even for several hours—than to risk bad handling. With such an unlucky combination of circumstances, it might rest with you to put into practice the knowledge you come here to acquire, but in such a case as this you must call in the help of strong arms, otherwise you will cause your patient needless pain.

As to the materials for making temporary splints and bandages, they are to be found in most houses: say a long-handled broom or garden rake, the sides of cigar or other light boxes or the frames of children's slates, for the splints; and handkerchiefs or torn-up towels or aprons for the bandages.

Let us suppose we are waiting the return of the policeman, and that you have asked me, "Why will splints and bandages make it safe to move this poor man, and why is it so dangerous to move him without them?" To the first question the answer is, because with splints and bandages we can make a fixture of the broken leg; and to the second, unless you first make the broken leg immovable with splints and bandages, you risk converting a simple fracture into a compound. A compound fracture does not mean a second fracture of the bone, but a flesh wound in addition to the existing fracture, through the ends of the broken bone having pierced the flesh. This creates a most dangerous condition, because the wound permits of the microbes in the air penetrating into the tissues. In the old days, before the treatment of wounds by antiseptic methods was understood, the victim of a compound fracture only too often had to purchase his life at the price of his leg or arm, and even now a compound fracture is one not easy to treat. A bone broken in many pieces is called a comminuted fracture; but alarming as this sounds, the pieces may grow well together and such a patient have a better chance of a good recovery than another with a compound fracture. A man with a fracture of a lower limb has only to put his weight on his foot, and the ends of the broken bone will force themselves through the flesh.

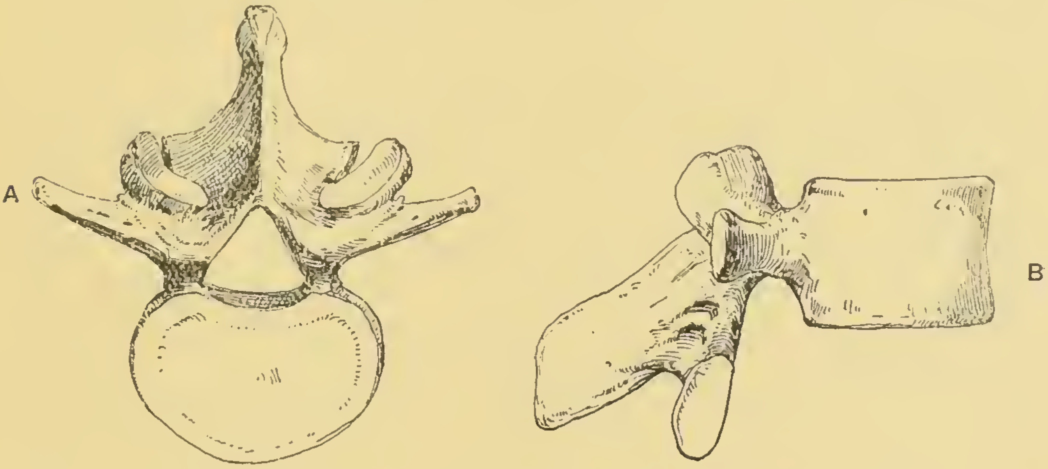

Fig. 39.—A lumbar vertebra.
A, Viewed from above; B, viewed from the right side.

With the help of the chart that shows the skeleton let us consider the form, position, and number of the bones that comprise our bony framework, or skeleton, injuries to which are the subject of this evening's teaching.

The central column of the skeleton—the spine—has thirty-three segments or vertebræ. If the spine were composed of one long bone, we would never be able to lean forward or to bend backwards. One half of each vertebra consists of a round piece of solid bone, constituting as it were a stone of the column, while the other half is arched (*Fig.* 39), and these open ring-like arches piled one on top of the other form the long canal in which, well protected, lies the spinal cord. An injury to the spine and spinal cord, like to the brain, may cause death or loss of power.

At the base of the spinal column, and attached to it, is a wedge-shaped bone called the sacrum, and on each side of it and spread out in a basin-like shape is the pelvis, or haunch bones.

In considering the general structure of the body, we see that, connected with the central column of the skeleton, are three bony cavities :—

1. The *Head*, composed of the skull and face bones. Contents : the brain.

2. The *Thorax*. This cavity is bounded by the chest bone (sternum) and the ribs in front, and the vertebral column and the ribs behind, while it is closed in above by the structures in the lower part of the neck, and at the base by a muscular flooring (the diaphragm). Contents : the heart, the lungs, and the alimentary canal.

3. The *Pelvis*. This, the lowest portion of the trunk, is separated from the thorax by the diaphragm, and is formed by the big haunch bones. Contents : bowels, liver, bladder, and other organs.

Connected with the chest are the upper extremities of the body—the arms and hands ; and connected with the pelvis, the lower extremities—the legs and feet. The former are united to the trunk by the collar-bones, which at one end articulate with the top of the breast-bone, and at the outer end with the spine of the shoulder-blade. No fracture is more common than a broken collar-bone. By the length and position of the collar-bones our shoulders are kept well apart, and they supply us with a strong point of resistance in all powerful movements of the arm, but their presence prevents our striking the ground with impunity, as can the horse and many other animals. Hence if we fall to the ground with all our weight thrown on our hands, we are pretty safe to have a collar-bone broken. The horse has no collar-bones and the dog only imperfect ones, otherwise they could not gallop and jump as they do ; on the other hand, they cannot, like man, raise weights with their fore-limbs.

We owe the delicate and complicated movements of which our hands are capable to the arrangement and form of the two bones of the forearm—the radius and the ulna (see the roller chart). They lie side by side when the hand is turned outwards, but the radius rolls and crosses over the ulna when the hand is turned inwards. When either of these bones is broken, we must bandage the arm with the thumb turned outwards, so as to keep the bones in their simplest position—not crossed. Man is enabled to withstand the concussion caused by using a hammer or other such tools, owing to there being in his wrist a multitude of little bones. The effects of a blow are thus divided, and its force consequently broken. In the wrist, there are no fewer than eight little bones, closely bound together by ligaments and circular bands of muscles. Thus the wrist, unlike the elbow or finger joints, can be bent backwards as well as forwards, and is altogether more flexible. In the hand there are five bones, and the four fingers with the thumb have fourteen, making up with those of the arm and wrist no fewer than thirty bones in the lower extremity of the upper limb.

In the leg and foot there are also thirty, but with this difference, that while in the ankle there is one fewer than in the wrist (seven, not eight), there is an extra little oval bone called the patella (or knee-cap) which covers the front of the knee joint. This bone is very liable to be broken if we fall on the knee sharply or if the tendons act strongly, as when someone about to slip makes a sharp movement to save himself. Then there are the big thigh-bone, corresponding to the humerus (or upper-arm bone), and the two bones of the lower half of the leg, as in the forearm, only, unlike the radius and ulna, they never cross.

Here come a policeman and bearers with a stretcher! Let us see what our qualified policeman does with the splints and bandages he has brought. (*Demonstration should follow.*)

It being the thigh-bone that is broken, the policeman does not content himself with splints bandaged on to the inside and outside of the thigh, but applies a stick from the armpit to beyond the heel, carefully pads the stick where it touches the ankle, to avoid pressure (see *Fig.* 25, p. 106). You will notice that before fixing the ankle he will gently pull down the foot, because he knows that, as the broken leg looks shorter than the sound one and has the foot turned outwards, the ends of the broken bone cannot be opposite each other, and he seeks to bring them as nearly so as he can. Absolute immobility of the whole side having been secured by these appliances, the bearers may now lift the man and carry him to the hospital, here setting and bandaging by a surgeon await him, and, let us hope, a good recovery at the end of six weeks.

[*At the close of this lecture a teacher should demonstrate, by means of a boy retained for the purpose, how to put into practice what is here described.*]

CHAPTER I continued.—LECTURE 2

FIRST AID IN CASES OF A FRACTURE—BANDAGES AND SPLINTS

To return to the patient with the broken thigh-bone.

Why do you think it was necessary to apply that long stick, or splint, from the armpit to beyond the ankle, thus making it impossible for the man to sit up? Because in such cases the action of the connecting muscles of the back and legs has to be corrected, and this can only be done by putting them under restraint, so obliging them to stop their work, that of pulling on the bones to which they are attached. This is the surgeon's forcible way of saying to the muscles what I said to you at first, "Hands off."

Muscular action prevails throughout all the fleshy masses which form our bodies, masses made up of many scores of muscles, each of which is composed of numerous fleshy bundles of contractile fibres, usually attached by strong tendons to some bone or bones. The bones have no power of movement, but are worked upon by the contractile action of the muscles attached to them. This contractile action, or power of self-shortening, is an inherent vital property possessed only by muscular fibres. It belongs to all classes of muscular fibre, but we distinguish between the class under control of our will and that not under control, calling the first "voluntary" muscular fibre and the second "involuntary" muscular fibre. We shall be concerned with the second when we study the action of the heart and the structures of the blood-vessels, but for the present we will confine ourselves solely to voluntary muscular fibre. Whence comes this inherent vital property we know as little as we do of the origin of life. We know it is stimulated or restricted by motor nerves, and we know also that not only is muscular fibre contractile but so is each of the millions of cells which go to make up muscular fibre—a life within a life—but as yet no one has penetrated further into this mystery.

Voluntary muscles are of all lengths and thicknesses, as needed for their destined varying offices. Some draw bones upwards, others downwards, or backwards and forwards. Some work in union with other muscles, while others act in direct opposition, and so set a safe limit to over-extension in any one direction, while they besides serve to maintain the balance of the body in the positions it assumes, whether the poise of a dancer on the point of her toes, or yours as you sit upright on the benches of this room.

Take as an example the simple movement of raising or bending a straight forearm. This is mainly brought about by the action of the big biceps muscle, which is attached at one end across the top of the humerus to the spine of the shoulder-blade, and by the lower end to the radius. Given the shoulder-blade as a fixed point, it is plain that the contracting or shortening action of the biceps as it draws its two ends towards each other must raise the radius and, along with it, its companion bone, the ulna. You can scarcely have failed to see how the contracted biceps swells out when you raise the forearm. When the biceps ceases to contract, the forearm perforce falls down, but this it does smoothly, because when the biceps to the front ceases to contract, the triceps behind contracts in its turn, and so regulates the unbending of the forearm which otherwise would drop abruptly.

Likewise, when the weight of the body falls on the bones of the foot, the body is prevented from falling forward by the contracting and retracting action of the great calf muscle, which is inserted by its long tendon—the tendon Achillis—into the heel, and by its upper tendon on to the thigh-bone. On the other hand, the thigh muscles, by contracting, serve to give a forward inclination to the body.

In each ordinary motion of the limbs, at least one hundred muscles combine to produce individual changes or to limit those changes, while in walking it is said that almost every muscle of the body then comes into play, either directly to produce progression or indirectly for the balancing of the head and body as their weight passes now on to one foot, now on to the other.

From what I have said you will I hope have gained some idea of how powerful and complicated is the action of bone enveloping muscles—playing on them as they do, now from afar, now from near; now with combined action, now with opposing forces; now continuously and now spasmodically; and you will therefore realize how necessary it is to protect a broken bone from such disturbing influences. Perfect immobilization can be successfully secured only by bandaging far beyond the actual seat of fracture. Therefore in the case of a broken humerus (which we are just about to consider), besides putting it in splints, we shall have to bandage the forearm too. Likewise, when we have to deal with a broken bone of the forearm, we shall also have to bandage the hand and wrist. (*Demonstrations should follow.*)

For a Broken Humerus.—Put a splint on each side. Bandage forearm. Sling arm and hand, but leave out the elbow so as not to force the lower end of the broken bone beyond that of the upper one, or through the flesh. (See *Fig.* 26, p. 108.)

For a Broken Radius or Ulna.—Put splints on forearm. Bandage hand and wrist. Sling arm.

For a Broken Collar-Bone.—Support shoulder by a pad in the armpit and by a broad triangular sling. As the sling is intended to remove a little of the weight, it ought for that purpose to include the elbow, so as to force it upwards. (See *Fig.* 27, p. 109.) Notice the difference between this sling and the narrow sling for a broken humerus.

For a Broken Rib.—Tie broad bandages firmly round the chest.

DAMAGED MUSCULAR FIBRES: STRAINS AND SPRAINS.

A Strain is a twist or over-extension of a muscle, or of a tendon of a muscle.

A Sprain is more severe than a strain, for it is a displacement or an injury of a tendon, and may be accompanied by the rupture of small blood-vessels.

Put no weight on a sprained hand or foot. Apply, or place in, very hot water as soon as possible. Bandages, rest, and later, friction with embrocations or spirit compresses, is the treatment. When pain has ceased, carefully graduated movements will hasten recovery. If there is effusion of blood under the skin, massage two or three times a day helps the blood-vessels to reabsorb it, and Pond's Extract as a compress is very useful for this purpose

CHAPTER II

THE BLOOD

LECTURE I

THE OUTGOING AND INGOING COURSES OF THE BLOOD.

Introductory Explanations.—*An Element.*—By this word is meant a substance in its simplest state ; one that cannot be split up. Water is *not* an element (though you often hear it loosely called so), because it can be split up into two gases, hydrogen and oxygen (H_2O). Neither is air an element, seeing that it contains three gases: nitrogen, oxygen (three times more nitrogen than oxygen), and hydrogen.

In the human body there are some fourteen elements. The most important for us to know of are the three gases, oxygen, nitrogen, and hydrogen, and a solid substance called carbon.

Oxygenated.—When we speak of tissues being oxygenated, we mean that they have been subjected to the consuming or burning action of oxygen (brought by the blood), which they have attracted.

Carbonic Acid.—A gas given off by tissues in proportion as they lose by the action of oxygen. The presence in the air of much carbonic acid is highly unfavourable to human life. In large quantities, or unadulterated, it is fatal.

Our life and health depend on the presence in our bodies of a sufficient quantity of well-circulated and properly oxygenated blood.

Blood constitutes one-thirteenth of the weight of the human body. If a man's weight is ten stone, then about one stone would be blood; but whatever the proportion is, there never is sufficient blood to fill all the blood-vessels at once.

Very great loss of blood will cause immediate death, while considerable loss will weaken the whole machinery of the body and tend to induce disease which may be fatal; therefore it should be our endeavour to stop bleeding as quickly as possible.

Sometimes it is not in our power to do so, owing to the situation of a wound, as in cases of deep stabbing—like that of poor President Carnot, who died from internal hæmorrhage—or bad gunshot wounds; but generally, bleeding can be stopped if prompt action be taken by persons who bring knowledge and presence of mind to bear. The appliances required for "First Aid" are so very simple that an intelligent person would rarely fail to find something within reach which could be made to answer. On the other hand, it is very easy to turn what should be only slight bleeding into a serious loss of blood, or to convert a trifling cut into a source of sickness and trouble, as I will show you by the three following stories.

In 1855, at the ceremony of bestowing medals on our troops returned from the Crimean War, an officer, Sir Thomas Troubridge, was present, who could only approach the Queen in a Bath-chair. When Her Majesty saw him she burst into tears, and said, as she pinned the well-earned medal on the maimed hero's breast, "I am so sorry, I am so sorry." Sir Thomas Troubridge had led the Royal Fusiliers at the battle of the Alma, and though his uniform was riddled with bullets, he received no wound during that action; but some months later, at the battle of Inkermann, a large shot struck him, carrying off his right leg and left foot. He fell close to a gun. Instead of allowing his men to remove him, as they wished, he directed them to lay him on the gun and to stick his stumps well up on the gun-carriage, in order to check the flow of blood; and in this position he continued to give his orders with the greatest coolness till victory declared itself for the English. Then, and not till then, did he consent to be carried on a litter to the rear to receive surgical aid.

We are not all called to be such heroes as Sir Thomas Troubridge, but let us remember when we have to deal with hæmorrhages how he saved his life by raising his bleeding limbs, and do the same. You will understand why it is the right thing to do when I have spoken to you about the circulation of the blood.

One day in my country home I heard a scuffling, screaming, and running about in the laundry court, which my window commanded, and I saw someone emerge from the laundry door with bloody fingers. I seized some bandages I had, and a bottle of sal volatile, and hurried down. I found a laundry maid standing on one leg while her companion held her other stockingless bleeding foot over a pail already partly filled with blood! I washed and bandaged the foot as quickly as I could, had her placed flat on the big ironing-table with her foot stuck up on a down-turned chair, administered some sal volatile as she was very faint, and sent for the doctor, because I was afraid from the position of the cut that lockjaw might set in. She had been trying to chop a piece of wood, and with the axe had cut deeply across the base of the big toe. It was an ugly wound. When some hours later the doctor came, he said her health would suffer for some time from so severe a loss of blood, and his words came true, for she was invalided and unfit for work for several months. So never do what her sympathizing fellow-servant did, *encourage* a wound to bleed, for by letting the bleeding foot hang over the pail this in fact is what she did. The pail certainly saved the floor from stains, but what was that compared with saving the poor girl from losing blood.

My third story concerns Maria Field, who suffered from what is called " a poisoned hand." One morning, before starting to work at a neighbouring house, she cut her hand on an old broken glass. By the evening the cut was inflamed. Daily it got more troublesome, swelling and gathering till she suffered so much, not only in her hand but in her general health, that she was forced to go into hospital and stay there for some time. Why did Maria Field's hand become so troublesome ? The cut was not a bad one, and the loss of blood quite insignificant. Let us see what she did after she went to work. Finding the handkerchief she had tied round her hand at the time in the way, and the cut inclined to bleed, she bethought herself of the remains of some old sticking-plaster. This she wetted and pressed into the cut with her fingers, dirty with the verdigris (green rust) of the brass lamps and candlesticks she was engaged in cleaning. In that cut the open mouths of the blood-vessels absorbed the dirt and the poison, which were carried throughout the body. Revolt against the presence of the poison arose, and what we call festering, or gathering, ensued—in reality an effort on Nature's part to cast out the poison and rid herself of the damaged tissues. But the work proved greater than the parts could manage, so the surgeon's knife had to be summoned to their aid, and this time the wound, now a considerable one, was antiseptically bandaged, and all dirt rigidly excluded. If Maria Field had in the first instance washed the small cut with water that had been boiled to render it aseptic, and had then been careful to keep the hand tied up, she would probably have had little trouble. Boracic lotion would have been better still, but that, most likely, she did not possess or even know of. Apropos of sticking-plaster, besides warning you that all sticking-plasters are by no means made of wholesome materials, I should like to ask you what you think it can do for a cut. I hope you do not imagine that, as in mending china, glass, or wood, you will be able to stick or glue the edges of the cut flesh together ? Quite the contrary, for any foreign substance getting between the edges will hinder their natural efforts to grow together, our cell-tissues being always more or less engaged in the work of renovation. Constant change is the order in our bodies, for bit by bit tissues are consumed, and are renewed each after its own peculiar kind. So the healing of a wound simply means, for the parts concerned, the continuation of their daily task with additional heavier overtime work, in proportion to the damage done. The process of healing may be so exhausting that, as in the victim of an extensive burn, the patient may be as much weakened by the process of healing as by the shock of the accident, and may die of exhaustion.

Sometimes it is convenient to use sticking-plaster, in which case use a good one, such as Lister's, but please bear in mind that it is never safe to cover over a wound *entirely* with any impervious material, for should suppuration arise pus cannot escape, and if it remains it must poison the blood. Bring the edges together and apply the strips diagonally, with spaces between them, and exclude air by absorbent and aseptic cotton-wool and bandages. Nature herself provides an adhesive plug in the coagulated blood that exudes from a cut, and this ought never needlessly to be removed, seeing that it acts as a first healing agent. Coagulated is a technical term which you will appreciate when you know more about the properties of the blood.

Composition of the Blood.

Let us recollect in the first place that the blood is composed of the same elements as the solid tissues of the body. These elements it draws from the food we eat and the air we breathe, and with them it feeds the tissues among which it passes or circulates.

Blood consists of an almost colourless liquid called "liquor sanguinis," and a great multitude of minute bodies termed "corpuscles," which float in the liquid. Some are white, but the greater number are red. Red corpuscles are circular flattened discs, compressible, and so minute that about 10,000,000 of them are required to cover one square inch.

When a drop of shed blood is examined under the microscope, the corpuscles are seen rolling and tumbling in the clear liquid, and in time arranging themselves into big rolls, like so many piles of coins. They owe their colour to a substance called hæmoglobin, with which their transparent filmy framework is infiltrated. The leading characteristic of hæmoglobin is its great readiness to absorb oxygen, and its equal readiness to give it up. It absorbs oxygen during the passage of the blood through the lungs, and in doing so becomes of a bright-red colour. It yields oxygen while the bood is circulating amongst the capillaries, and there grows dark coloured.

The blood is the carrier of the body. The carrying is rather a complicated business—a sort of Carter Paterson van service and Vestry ash-cart service in one—worked to gratify the tastes of the principal agent "Mr. Hæmoglobin," and for the good of the neighbourhood it serves.

The main commodity of one district has a particular attraction for "Mr. Hæmoglobin," so he takes largely of it into his vans, but while passing through further districts he finds other goods which have a still stronger attraction for him, and a demand from their inhabitants to supply them with what he has already got. He makes room for the latest favourite goods, and the inhabitants benefit by the good materials left behind for their furnaces, the ashes of which he obligingly arranges to carry away as required.

Imagine a Black Monday when "Mr. Hæmoglobin's" vans pass and leave little or no materials. Loud the murmurs, long the faces of the inhabitants. "Our fires will soon be out, and then the leg and arm machines and the force pump will stop work!" "I cannot help it, there are no supplies to bring, and I myself am getting very blue" (cyanosis). Such bad days there are for people who do not get a sufficient amount of air, with its right proportion of oxygen, and it is quite as bad as not having sufficient food to eat.

COAGULATION.

Blood is fluid when first shed, but it soon becomes semi-solid and jelly-like, and if examined somewhat later, a superficial layer of pale straw-coloured fluid would be seen forming in an ever-increasing quantity on its surface. In proportion as this happens the jelly becomes always firmer and firmer, till it forms a complete clot in a fluid serum. If such a clot be examined under the microscope, it will be found to consist of a network of fine granular fibrils, in the meshes of which are entangled the red and white corpuscles. These fibrils are composed of a substance called fibrin. The growth of fibrin is spontaneous, and its presence is the cause of coagulation.

Coagulation takes place within our bodies after death, but in living bodies only in certain damaging circumstances, such as a foreign body in a blood-vessel, injury to the inner coat of a blood-vessel, as in aneurysms, or where the circulation is artificially stopped locally. For this last reason a bandage should never be applied too tightly, or if tightness is necessary, only maintained for as short a time as possible, for protracted constriction by a tight bandage would cause gangrene of the parts beyond, from an arrested arterial circulation.

CIRCULATION OF THE BLOOD.

How does the blood circulate? It is propelled by the heart, and carried throughout the body by a series of tubes, or pipes, known as the *blood-vessels*, which communicate with the heart.

Blood-vessels are of three kinds, each having its own office to fulfil: (1) The *Arteries*. Strong and elastic, they bear away bright-red blood *from* the heart and terminate in (2) The *Capillaries*. These are the smallest blood-vessels, and form a network through and round all the tissues; and out of them rise (3) The *Veins*, which carry *back* impure dark blood to the heart.

The *Heart* is the centre of action—a very force-pump—its contractile muscular fibres supplying the motive power. It is a muscular hollow organ which beats rhythmically and automatically. With each of its beats it discharges a certain quantity of blood down the arteries, and at each pause it receives back into its cavities blood brought by the veins.

The structure of the heart is complicated, but it is necessary for our purpose that you should know something of it.

An upright partition divides it into halves, in each of which are two chambers, an upper and a lower, called the auricle and the ventricle, communicating with each other by valves, or trapdoors. Between the halves of the heart there is no direct communication, only a circuitous one.

We might roughly compare the heart and the circulation to two covered platforms, built back to back within one station, with double lines in common but with no passage through the station itself. Passengers leave by platform A, make journeys on the outgoing lines to the country market-places, buy and sell, and return, exhausted and soiled, by the ingoing lines to platform B. These passengers are the red corpuscles of which I spoke. Platform A is the left half of the heart; the out-going lines are the arteries; the market-places are the capillaries, and the incoming lines the veins which conduct the corpuscles to platform B, the right half of the heart.

What really happens is this. Dark unoxidized blood is forced by the big venæ cavæ into the right auricle; when full, this contracts and its contents pass through a valve down into the right ventricle, which likewise contracts, and in so doing expels the blood by the pulmonary artery on its way to the capillaries of the lungs. There it absorbs oxygen and grows bright-red in colour. Thus altered, it is carried by the pulmonary veins to the left auricle of the heart; and what happened in the right chambers is repeated, and repeated simultaneously, by the left half of the heart, and finally, by means of the contractions of the powerful left ventricle, the blood is forced into the aorta, our great main artery, and is fairly started on its greater circle throughout the world of branching arteries, capillaries, and veins, to be poured by the venæ cavæ back into the right auricle.

The course I have described is called "The Circulation," or

Greater Circle, but there is also an Inner Circle, " The Pulmonary Circulation."

To return to the three kinds of blood-vessels.

(1) The *Arteries* are strong, and in youth and middle age elastic, after which they sooner or later lose much of their elasticity.

The arterial walls are composed of: (*a*) A delicate inner coat, known as the " intima," which from its smoothness and position might be compared to the glaze on the inner surface of an earthenware pipe, for it provides the smooth surface over which the blood flows; (*b*) The middle and thickest coat, on which the artery mainly depends for its elasticity and strength; and (*c*) The outer coat, in which, unlike the middle coat, there is a large proportion of connective tissue. Besides these three coats, there is what is tantamount to a covering or sheath. The elasticity of the walls of the aorta, for example, is proved by the way it expands and makes room for each successive jet of blood, though already full. These accessions of blood are what we feel in the beats of the pulse, and they correspond in time and frequency to the beats of the heart.

(2) The *Capillaries* form a close fine network throughout the body, and are the connecting link between arteries and veins—the former ending, the latter beginning amongst them. The blood flows much more slowly in the capillaries than in the veins and arteries, partly because of their vast number and the minuteness of their passages, and partly because it is among them that the blood has to do its work of feeding the tissues and picking up waste products.

How is this possible? Because the membrane of the walls of the capillaries is so delicate that the liquor sanguinis flowing in the capillaries can pass through it into the tissues among which they lie. In the same way oxygen can pass from the lung air-cells, and carbonic acid, that waste product of the tissues, can pass into the capillaries, and liquids, and therefore digested food materials too, can be absorbed by the capillaries of the stomach, and from there some pass directly into the blood. This property of membranes is called "*osmosis*."

Though the blood lingers in the capillaries, no one length of its course is longer than from one-half to three-quarters of an inch among any one set of capillaries before the veins gather up the blood from amongst them to return it to the heart, and as the veins increase in size so does the amount of blood they carry to the heart.

(3) The *Veins* are more often visible than are the arteries and capillaries, for many of them lie just beneath the skin, though the most important ones are too deeply seated. The walls of veins are not muscular but flabby, and collapse when

empty. Their peculiarity is the presence on their inner surface of numerous little pocket-like valves. These serve to direct the blood to the heart and to prevent its return. If you press on a vein, say in the arm, so as to stop the flow between the hand and the shoulder, you will soon see a series of little swellings or knots rising in the vein. They are the little overcharged pockets. Remove the pressure, and the vein will empty and the pockets flatten down.

Some of the impetus given by the heart remains even in the veins, but it is very slight as compared with the arteries ; on the other hand, in veins the blood is driven onward by the contractions of their surrounding muscles. Hence the great difference between arterial and venous bleeding, and the importance of stopping the former as quickly as possible, for though both may prove dangerous, as the flow of blood from the former is more rapid, it necessarily brings greater loss in a given number of seconds.

CHAPTER II continued.—LECTURE 2

HOW TO STOP BLEEDING

HAVING studied the action of the heart and the course of the blood-vessels, let us see what practical measures towards arresting hæmorrhage our knowledge would lead us to take.

(1) Knowing that the heart is the centre of the circulation and that all blood comes from and returns to it, we would naturally raise a bleeding limb in order to induce the blood to return to the heart, or to slacken in its downward rush to the open wound. (2) Since the veins carry the blood back to the heart, in cases of venous bleeding the clothing about the heart ought to be loosened to facilitate this return of blood, and pressure put *beyond* the wound, not between it and the heart. (3) Knowing that the heart propels freshly oxygenated blood down the arteries, we know we have to deal with arterial bleeding if we see the blood flow in jerks and spouts, and if its colour is bright-red, and we should therefore apply pressure *between* the heart and the wound.

To apply pressure to an artery is best done by pressing the artery above the wound against a bone, either with the hand or with a tourniquet. But in order to place the pad in the right place, we require to know, or feel, the course of the artery concerned; so I will try to give you an idea of the course of the principal arteries, especially those of the upper and lower limbs, as they are the ones most likely to be wounded. Bad hæmorrhages would occur more often were it not that most of the larger veins and arteries lie in the least exposed parts of our bodies, the arteries being for the most part well covered by muscles, etc., though a few arteries run near enough to the surface to allow of their pulsation being felt.

THE COURSE OF SOME ARTERIES.*

The left ventricle, as we saw, expels its blood into the aorta—the large main artery.

The *Aorta* ascends in a powerful arch to above the top of the heart and descends behind it along the left side of the spine and through the diaphragm into the abdomen. From its arch arise, directly or indirectly, the two common carotids (neck arteries) and the subclavians (collar-bone arteries). Each carotid subdivides into two pairs, the internal and the external carotids, the external continuing past the ear to the brow, where they become the temporal arteries.

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* See Figs. 14–16, pages 47–49.

The skull being bony, the temporal artery can be pressed against the brow or the external carotid against the jaw, in order to stop bleeding from head or face, but to apply pressure to the neck arteries is both difficult and dangerous except for a surgeon. Besides causing suffocation you run the risk of injuring the great nerve which descends by the neck from the head, and which controls the actions of the heart.

The subclavian arteries pass, one on each side, under the collar-bone and over the first rib, to the armpit. For a wound in the armpit, besides pressing on the wound itself, compress the subclavian by pressing into the hollow which children call the "bird's nest," where you can feel the pulsation of the artery.

The *Axillary* (or armpit artery) is a continuation of the subclavian, and after crossing the armpit, it ends in the brachial (or upper-arm artery). This artery, too, is easily found and can be pressed against the humerus, and by so doing we can control bleeding from the forearm or hand. A little above the bend of the elbow it divides into two, the radial and the ulnar arteries, one on each side of the front of the arm down to the wrist, where they give off branches to the palm and fingers. To stop bleeding from the hand, press on *both* these arteries about an inch above the wrist.

To return once more to the aorta. Having passed through the diaphragm and abdomen, it forks into the common iliacs, and from the large subdivisions of these trunk arteries on into the internal and external iliacs.

The *Femoral* (or thigh-bone artery) is a continuation of the external iliac. It descends along the inside of the thigh for two-thirds of its length, and then passes to the back of the thigh, where it becomes the popliteal (or ham artery). To stop bleeding of these arteries, apply pressure to the middle of the fold of the thigh above the wound.

In the lower leg, as in the forearm, there is a pair of leading arteries (tibial and peroneal), which descend each side to the back, behind and outside the ankle bones. In further branches they pass round the ankle or into the sole of the foot. To control bleeding from the foot, compress behind the inner or outer sides of the ankle and on the middle of the front of the ankle.

THE DEMONSTRATIONS TO BE GIVEN.

Exercise I.—To find the controlling arteries of the arm.

Exercise II.—To find the controlling arteries of the foot.

Exercise III.—How to apply tourniquets so as to compress an artery against a bone.

[*The teacher should show, upon a pupil's arm, how to tighten a bandage with a pencil to do duty for a tourniquet.*]

SET OF PLAIN RULES FOR GENERAL TREATMENT.

1. Send for a surgeon if possible, but *at once* make the wounded person lie down, and raise the bleeding part above the level of the body.
2. Examine and cleanse the wound with water which has been boiled.
3. Press with tips of fingers and thumb directly over the bleeding spot until you get bandages and help.

For Bleeding from the Arteries.—Tie a pad made of some hard substance tightly on to the wound, and another on to the main artery on the side nearest the heart, and use a tourniquet to make both sufficiently tight.

For Bleeding from Veins.—The same treatment as for arteries, only the pad must be beyond the wound, farthest from the heart, and it is good to loosen any tight clothing about the heart.

For Bleeding from both Arteries and Veins.—Bandage and apply pads on both sides of wounds.

In Fainting from Loss of Blood.—Hang the head down. Fainting tends to *stop* bleeding, stimulants increase it.

AT CLOSE OF INSTRUCTION.

We have been studying the marvellous mechanism of our bodies, and how to protect them, or rather how to save life in accidents, and diminish their bad results.

We cannot do a better thing, but do not let us forget that though science and care can do much to raise the average length of human life, that each life has a limit as certainly fixed for it as has any eight-day clock, and that no man can pass his God-ordered term of years, be he ever so carefully guarded or blessed with ever so sound a constitution. The soundest as well as the weakest are equally death-stamped on coming into this world.

Take any old person who has been fortunate enough to escape all accidents and disease, and whose organs have worn evenly —a rare occurrence. To him death in all probability will come through those changes in the arteries about which we have been speaking. In old age these have lost their elasticity and are rigid channels, no longer capable of controlling the circulation, nor consequently of supplying the tissues with nutritive materials. When this point is reached, bodily weakness rapidly increases, till the struggle can no longer be carried on, and the heart ceases to beat. With its last beat life closes.

The stages of human life are unalterable: From birth to infancy, from growth to complete development, by decline to old age, and finally by decay to death. Life follows its cycles as surely and unalterably as does the earth its cycles of days and years. Throughout life there has been renewal upon renewal in the body, but at last comes death, with no possibilities of renewal. Yet can we imagine that an identity never lost during all the changes of a constantly changing body is to be obliterated by its final change on earth; or that a life whose springs have been renewed so often is to vanish or to be separated from Him who is Life and in whom we live and have our being? Surely not.

Let us therefore cherish and guard our bodies, and use to the utmost the marvellous instruments God has given us. Let us all work, and help others to work, while it is called To-day, and look forward to the To-morrow of Death, not as to a cruel Inevitable, but as to the last miracle-working change which shall bring us Life, and Life Eternal.

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